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Managing WINTER SHEEP RANGE for greater profit



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U. S. DEPARTMENT OF AGRICULTURE



Growth Through Agricultural Progress

MANAGING WINTER SHEEP RANGE FOR GREATER PROFIT

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INTRODUCTION

Good management of the winter ranges of Utah, Nevada, southern Idaho, and southwestern Wyoming is required in profitable sheep production. Under good management wool and lamb crops are increased and sheep condition improved. Death losses from malnutrition are eliminated and requirements for supplemental feed are greatly reduced. All these benefits tend to increase the net income the sheep owner receives. Good management results in continued high sheep production and maximum sustained income.

Also through good management, ranges in fair or poor condition are greatly improved; those in good condition are maintained in full production. Desirable forage species increase in vigor and numerous seedlings are produced; growth and development of these add materially to the forage crop. In a large measure desirable species replace undesirable ones, thus improving both the amount and quality of forage.

Forage produced on the winter ranges is one of the important resources of the West. It provides grazing for 4 to 5 million sheep for 4 to 6 months each winter from November to April. These ranges are

¹ Maintained by the Forest Service, U. S. Department of Agriculture, for Nevada, Utah, southern Idaho, and southwestern Wyoming, with headquarters at Ogden, Utah.

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arid, usually receiving less than 10 inches precipitation annually. The sparse vegetation, consisting chiefly of low shrubs and grasses, grows during the spring or summer, cures well on the stem, and provides good winter forage for sheep.

Heavy and unregulated grazing, from about 1880 until recent years, killed or injured many of the more palatable species and reduced forage production. During times of drought, plant mortality was severe and forage was woefully inadequate to care for the livestock. With the inception in 1934 of the Grazing Service (now the Bureau of Land Management) unregulated grazing was eliminated and a period of range rehabilitation and improvement was begun.

Research by the Intermountain Forest and Range Experiment Station, U. S. Forest Service, on the winter ranges of Utah and Nevada demonstrates procedures for and practicability of improving both forage and sheep production on these ranges through better management. Information and recommendations in this bulletin are based primarily on research studies made at the Desert Experimental Range,² 40 miles west of Milford, Utah, near the Nevada State line. These results are considered to be directly applicable to the salt-desert shrub and black sagebrush areas which cover approximately 46 million acres or 71 percent of the winter range within the Intermountain region. Stockmen can profit by applying these procedures to their own winter ranges.

HOW TO MANAGE WINTER SHEEP RANGE

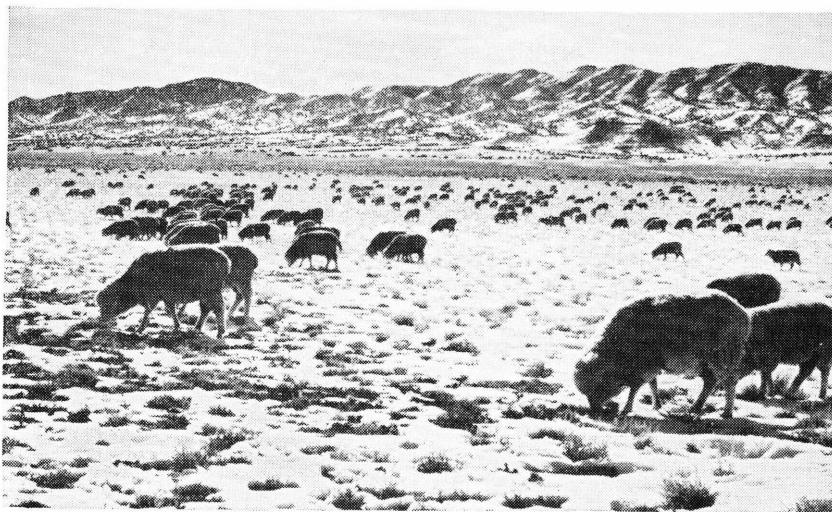
Good range management provides for protection and improvement of the soil and plant cover, and utilization of the forage crop, as well as care of the sheep grazing the range. The sheepman has at his disposal many tools to aid him. Knowledge of important species, annual measurement of the forage crop, and periodic evaluation of range condition are all essential in applying good management. With this information at his command the sheepman can balance grazing with forage, provide for moderate and uniform use of range, eliminate excess trailing, provide adequate water, and have on hand ample supplemental feed for emergency periods (fig. 1). The application of any one of these practices will be beneficial but maximum benefit comes with the careful use of all.

KNOW THE IMPORTANT RANGE PLANTS

Good grazing management is concerned primarily with the maintenance, production, and utilization of desirable forage species. These plants largely control grazing capacity, while range condition is evaluated on the basis of association and relative vigor of the desirable and undesirable forage species. Stockmen and range managers therefore should know the important range plants, both desirable and undesirable, their growth requirements, and their forage quality.

Several hundred different plants are found on the winter range but only about 50 are considered important species. Some are good

² This research is reported in U. S. Department of Agriculture Circular 925, Increasing Forage Yields and Sheep Production on Intermountain Winter Ranges.



F-440852

FIGURE 1.—Good herd management under ideal winter range conditions. Sheep are spread out, grazing quietly, and in good condition. The soft snow and well exposed plants of the desirable winterfat and bud sagebrush provide ample water and forage.

forage species while other, like Russian-thistle, cheatgrass brome, halogeton, and snakeweed have little or no forage value on winter range, but are important because they provide plant cover on deteriorated ranges and serve as indicators of range condition. Some of these species like Russian-thistle and cheatgrass brome, although not considered as good winter forage, are readily grazed on spring and early summer ranges when the plants are green.

Sheep show strong preferences for certain plant species. Some are readily eaten, others only lightly grazed. A few are rarely used except when the range is overgrazed. Therefore not all plants growing on the winter range can be considered sheep forage. This gives rise to one of the major problems in range management—maintaining or building up grazed, desirable forage species where they compete with ungrazed, less desirable species.

The sheep tend to crop the same forage species each year to approximately the same degree except when wide differences in forage production or stocking rate occur. Therefore average utilization of the various forage species furnishes an important tool for judging grazing use.

The desirable forage species are those that can be maintained in abundance on ranges in good condition. They are highly nutritious, and are grazed well by sheep. On the average, sheep eat 40 percent or more of the current growth of these plants when the ranges are properly grazed. Higher utilization is possible without harm to these plants than if they were being grazed during the growing season because the plants are dormant and food reserves are translocated to the stems and roots. Fair and poor forage species are those that are normally utilized less than 40 percent.

On most winter ranges in good condition, desirable forage species are relatively abundant and furnish most of the forage. When these species are properly grazed and maintained in thrifty, vigorous condition in the plant cover, the ranges continue to produce the greatest amount of usable forage. Therefore the utilization and condition of the desirable forage species serve as important guides to good management.

Species on the winter range classified as to forage quality, together with recommended use in percent are given in the following list:

	<i>Recommended use of annual growth (percent)</i>		<i>Recommended use of annual growth (percent)</i>
<i>Good forage species</i>			
<i>Fair forage species—Con.</i>			
Shrubs :		Grasses—Continued.	
Spiny hopsage	80	Sand dropseed	25
Black sagebrush ¹	70	Saltgrass	25
Winterfat ¹	60	Blue grama	20
Bud sagebrush ¹	50	Forbs (weeds) :	
Fourwing saltbrush	50	Bassia	35
Gardner saltbrush ¹	40	Lambsquarters	30
Grasses :		Pepperweed	25
Indian ricegrass ¹	75	<i>Poor forage species</i>	
Alkali sacaton	75	Shrubs :	
Squirretail	75	Snakeweed	15
Needle-and-thread	50	Small rabbitbrush ¹	10
Galleta ¹	45	Rubber rabbitbrush	10
Salina wildrye	45	Black greasewood	5
Mormon needlegrass	45	Seepweed	5
Forbs (weeds) :		Littleleaf horsebrush	0
Globemallow	80	Cacti	0
Encelia	75	Pickleweed	0
<i>Fair forage species</i>			
Shrubs :		Grasses :	
Fringed sagebrush	40	Cheatgrass brome	10
Gray summer-cypress	35	Fendler three-awn	5
Shadscale ¹	25	Sixweeks grama	5
Littleleaf mountain-mahogany	25	Foxtail brome	5
Big sagebrush	20	Forbs (weeds) :	
Nevada ephedra	20	Loco	10
Grasses :		Russian-thistle ¹	10
Bearded bluebunch wheatgrass	30	Halogenet ¹	0
Nevada bluegrass	30	Other annuals	0

¹ Description, drawing, and other information on this important species are presented in the last section of this bulletin.

When sheep first graze over a range, they select only the most choice forage species and eat the most relished portions of the plants, such as the stalks of Indian ricegrass and black sagebrush, tender shoots of winterfat, and green leaves of some grasses. After the choice tidbits are eaten, sheep take larger quantities of the desirable forage species and finally eat some less desirable plants.

Frequently desirable forage species are fully utilized before the fair and poor ones are grazed to an appreciable extent. For example, only 10 percent of the Russian-thistle, snakeweed, or small rabbitbrush is utilized when the more palatable species such as black sagebrush, winterfat, and Indian ricegrass are properly grazed. Littleleaf horse-

brush, Fendler three-awn, and foxtail brome are practically unused on properly grazed ranges.

Forage species vary in abundance on different parts of the range. Therefore sheepmen should list the desirable species on each area and base management on the utilization and condition of these species. This is particularly true on ranges in fair and poor condition where desirable forage species are closely grazed and often make up only a small part of the vegetation. If these are to be improved and restored to full production, grazing must be adjusted to permit them to grow.

On ranges where the vegetation consists almost entirely of one or two species, such as in shadscale or winterfat areas, management will of course be based on the primary species present in spite of the fact that they may not be highly desirable. On these areas, even though the primary species are not highly desirable, it is worthwhile to maintain scattered, choice species to add variety to the forage.

The use of some species varies greatly during different periods of the winter. Spiny hopsage is eaten only in late winter, when succulent new growth is available. Bud sagebrush is grazed to some degree all winter long but is eaten most readily in late winter, when the plants begin to grow. Gardner saltbush, fourwing saltbush, winterfat, and black sagebrush are utilized throughout the winter. Indian ricegrass, squirreltail, and Salina wildrye are also grazed all winter, but more heavily in the late winter period when new green leaves are produced.

In years when plant growth starts early so that new green vegetation is available during the late winter period, sheep eat large quantities of the new herbage. In fact, they travel over wide areas in search of it. At first their diet consists mainly of early-growing grasses. As the growing season advances, shrubs such as bud sagebrush, hopsage, and winterfat begin to grow. This new growth furnishes ample green forage. In years when spring growth begins in March, green forage is available for 3 or 4 weeks during the latter part of the winter grazing season. When spring growth is delayed, only a small amount of green herbage is produced before sheep leave the range.

Most grazing on winter range is done during the period when plants are dormant, but twigs and leaves of a few shrubs such as black sagebrush and winterfat remain alive and somewhat green in most years. Grasses generally are cured and dry, but a few, such as squirreltail and Nevada bluegrass, begin to grow in the fall and put out a few basal leaves which remain green throughout the winter.

Winter forage consists chiefly of mature, dry herbage and much of it is low in nutritional quality. Dry grass herbage is low in protein and phosphorus but is relatively high in carbohydrates and cellulose. Shrubs, in comparison with grasses, contain almost twice as much protein and phosphorus and thus provide a better balanced forage. Sheep prefer a mixed diet of grasses and shrubs. If palatable grasses are available in sufficient quantity, about 30 to 40 percent of the forage eaten daily will consist of grass. Sheep obtain the most nutritious and best-balanced forage where a variety of desirable forage species such as black sagebrush, bud sagebrush, winterfat, Indian ricegrass, and galleta are abundant.

Because the principal winter range plants are dormant in the winter season when the grazing is done, the percent of their current growth

that can be safely grazed is higher than on other ranges grazed during the time that plants are growing. Even, so, extremely close grazing can injure them. Shrubs store much of their food reserves in the twigs, from which new growth begins. Enough of the twig growth must be left to maintain a good reserve of plant food. Also, enough stubble must be left on the grasses to protect the root crowns and the new growth from frost damage and to provide litter for protection of the soil against erosion.

EVALUATE RANGE CONDITION

Forage production, grazing capacity, and grazing management are all influenced by range condition. Therefore, evaluation of range condition is an important prerequisite to good management (fig. 2).

Condition of a range is a rating of its relative health or production. It is also a measure of how well the range is producing in relation to what it could produce. The criteria or standards used to judge range condition are amount of ground covered by vegetation, presence and relative abundance of undesirable and desirable forage species, vigor of desirable forage species, and extent of soil erosion.

Range condition is usually classified in the general terms good, fair, poor, and very poor. The following descriptions of these classes are given as general guides to appraise range condition.

1. *Ranges in Good Condition.*—A range in good condition produces nearly the maximum forage that is possible under the climatic conditions. Vegetation consists chiefly of a good stand of desirable forage species such as winterfat, black sagebrush, bud sagebrush, galleta, Indian ricegrass, squirreltail, hopsage, globemallow, and Gardner saltbush. These species are thrifty and vigorous and make up 80 to 90 percent of the vegetation. Young plants of desirable species are abundant enough to maintain these species. Swales are covered with vegetation, plants are not markedly pedestaled. Although normal erosion is high on winter ranges there is little evidence of accelerated wind or water erosion on ranges in good condition except following heavy torrential summer storms. Soil is loose and friable and able to absorb the maximum amount of moisture.

2. *Ranges in Fair Condition.*—The vegetation is thinned. Dead root crowns of Indian ricegrass or stubs of dead woody roots of desirable shrubs such as winterfat, black sagebrush, or bud sagebrush are scattered throughout the vegetation. These tend to be replaced by living, vigorous plants as the ranges improve. Undesirable species such as shadscale, small rabbitbrush, Russian-thistle, halogeton, cheatgrass, or foxtail brome are usually scattered throughout and are abundant on a few localized spots. These species make up 5 to 30 percent of the total yield. Soil shows some signs of recent erosion, especially along the small drainage channels where the vegetation is broken or injured by grazing.

3. *Ranges in Poor Condition.*—The desirable vegetation is badly thinned, and numerous dead or partially dead plants of the desirable forage species can be noticed. Introduced annuals are numerous. From 30 to 50 percent of the vegetation is composed of undesirable species such as small rabbitbrush, Russian-thistle, halogeton, mustards, and cheatgrass and foxtail brome. Most of the young plants



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FIGURE 2.—Grazing capacity of winter ranges is greatly affected by range condition. *A*, Shadscale-winterfat range in good condition with the vegetation consisting of a mixture of winterfat, shadscale, Indian ricegrass, and galleta, mostly good to choice forage. Grazing capacity of such ranges averages 2.0 to 2.5 acres per sheep per month. *B*, Shadscale-winterfat range in poor condition on which Russian-thistle has replaced most of the better forage plants. Such ranges may require 5 or more acres per sheep per month. *C*, Shadscale-winterfat range in very poor condition on which most of the grazing capacity has been lost, all the winterfat has been killed, and wind erosion is active.

are of these invading low-quality species. Soil erosion is active. Many of the plants are pedestaled. Much of the vegetation in the smaller drainages has been killed and the drainage channels are actively eroding.

4. Ranges in Very Poor Condition.—Most of the desirable forage species are severely injured or destroyed. Dead crowns of grasses and stubs of desirable species are usually present. The vegetation is dominated by undesirable species such as small rabbitbrush, Russian-thistle, halogeton, and foxtail and cheatgrass brome. Soil erosion is much more severe than it is on a range in fair or poor condition.

On some ranges in very poor condition, where the native perennial vegetation is almost entirely destroyed, the soil is carried away by wind or water, leaving the plants pedestaled. The heavier particles of sand and silt are deposited in miniature dunes to the leeward of the vegetation. The finer particles of clay are carried great distances by the winds that sweep the valleys. When the vegetation is destroyed on the valley slopes and foothills, erosion along the drainage channels is increased. Such soil erosion is a two-way loss. The fine particles, which are richest in plant nutrients, are carried away and hence the production of the range is reduced. Where the silt and sand are deposited, other vegetation is covered and destroyed. The raw disturbed areas are invaded by annuals or other undesirable forage species, such as halogeton and Russian-thistle. Although both species are practically worthless as forage and halogeton is considered poisonous to sheep, the annual cover that they provide greatly retards soil loss.

By careful examination of the range a stockman can determine (1) areas in good condition; (2) areas in fair and poor condition that can be improved through management; (3) areas in very poor condition where reseeding may be needed; and (4) areas where poisonous halogeton or other undesirable species are present (fig. 3). In other words, an evaluation of range condition provides a basis for working out suitable management plans for his range.

It is well known that variations in precipitation cause wide fluctuations in herbage yield and grazing capacity from year to year. However, range condition, which is determined by the relative production of desirable and undesirable forage species, is only partly due to changes in precipitation.

Some of the desirable forage species when in vigorous condition are more drought resistant than the less desirable ones. In years of low rainfall, yields of black sagebrush, winterfat, and Indian ricegrass, for example, are often reduced about 50 percent or more while Russian-thistle is reduced 90 percent or more. In drought periods such as 1933-34 or 1942-43, almost 30 percent of the shadscale died while black sagebrush, bud sagebrush, and winterfat suffered little mortality.

Injury or destruction of good forage species, invasion of Russian-thistle and halogeton into winterfat areas, or the replacement of black sagebrush by rabbitbrush are nearly always produced by overgrazing and not by drought or changes in precipitation. Ranges stocked on the basis of full use during average or better than average years are grazed too heavily in years of low rainfall. During these periods, plant mortality is accentuated and range deterioration caused by overgrazing.



F-467259

FIGURE 3.—A dense stand of halogeton on deteriorated shadscale range in southern Idaho.

GRAZE MODERATELY

The most important part of good management is moderate grazing. It assures adequate forage for the sheep, leaves enough herbage on the desirable forage species to keep them healthy and vigorous, provides for the establishment and growth of seedlings of desirable forage species, and assures the maintenance of enough vegetation and litter to protect the soil from excessive erosion. To provide for moderate grazing year after year, the range must be stocked properly. In doing this allowances must be made on each range area for variations in herbage production and range condition.

Determine Proper Number of Sheep To Be Grazed

The proper number of sheep to be grazed on a range during the winter grazing season, i. e., grazing capacity, is determined primarily by the kind and amount of herbage produced and the condition of the range. This number varies widely with vegetation and range condition. Therefore, no single grazing capacity figure can apply generally to all winter range areas. Stocking rate should be in balance with forage production and should be determined for each range area on the basis of the forage yield.

The range should be stocked according to the best estimates of grazing capacity which can be obtained. These should be modified or adjusted later by careful and frequent checks on forage utilization and range condition. Preliminary estimates of grazing capacity can be made by several methods.

Very good estimates of grazing can be made by measuring herbage yields on the range, but this requires the aid of trained technicians. The data must also be carefully compiled and allowance made for areas in fair or poor condition. The approximate amount of usable feed on a range can be determined by multiplying the air-dry herbage yields of individual species by the average utilization percentages given in the list on page 4 and dividing the total of all species by 100. The number of sheep-days can be determined by dividing this figure by 5½ pounds. Although sheep do not actually eat 5½ pounds of forage daily, that amount is either utilized or destroyed during the grazing season.

Stocking rates based on past records of use can serve as an index to grazing capacity. This is particularly true if the range has been improved or maintained in good condition. However, if the range has shown no improvement or if the desirable forage species are being injured or destroyed, fewer sheep should be grazed or the grazing season shortened. If the range is in good condition and more herbage is left ungrazed than is needed to keep the desirable forage species thrifty and productive, more sheep can be grazed.

Stocking rates on similar nearby ranges which are properly grazed can also be used to make preliminary estimates of grazing capacity. In applying this information, it is necessary to allow for differences in herbage production and range condition of the two areas. Stocking rates used at the Desert Experimental Range, which provide for range improvement, can serve as useful guides on other similar range areas.

On a large experimental area of winter range, most of which was in fair to good condition, an average of 2.3 acres per sheep per month was required to provide sufficient forage for the sheep and still leave enough herbage to improve and maintain the desirable forage species. On areas where highly palatable species such as Indian ricegrass, winterfat, and black sagebrush produced most of the herbage, only 1.2 acres were required, and on shadscale range, 3.5 acres.

Allow for Range Condition

Ranges in good condition have considerably greater grazing capacity than those in poor condition because they produce more total herbage and a greater proportion of desirable forage species. Estimates of grazing capacity of winter ranges in good and fair to poor condition in western Utah and Nevada are as follows:

Vegetation :	<i>Good range (acres per sheep- month)</i>	<i>Fair to poor range (acres per sheep- month)</i>
Shadscale—grass	3.5	5.7
Shadscale—winterfat—grass	2.3	3.7
Black sagebrush—shadscale—grass	1.0	2.3
Winterfat—small rabbitbrush—grass	1.2	2.8
Littleleaf mountain-mahogany—black sagebrush—grass	2.8	4.3
Winterfat	1.0	2.4
Gray summer-cypress—Gardner saltbush—winterfat	1.9	2.6

On range in good condition 1.0 to 3.5 acres were required per sheep-month depending on the vegetal type. Ranges with similar slope

and soil characteristics but in fair to poor condition have only one-third to one-half as much grazing capacity. Ranges in very poor condition produce little or no usable forage.

To encourage rehabilitation of ranges in poor condition, the better forage plants should be grazed less than is recommended on ranges in good condition. The desirable plants in weakened condition require greater protection and food reserves to restore them to thrifty, vigorous production, so they can compete successfully with less desirable plants.

Allow for Variation in Forage Yield

Forage yields on winter ranges vary widely from year to year. For example, at the Desert Experimental Range in western Utah, forage production over a 13-year period 1935-47 on shadscale-winterfat range in fair to good condition varied from a minimum of 30 pounds per acre in 1943 to a maximum of 169 pounds per acre in 1947. The average was 81 pounds per acre (fig. 4).

Maximum grazing use of winter ranges can probably be obtained by varying the stocking each year in accordance with forage production as was done at the Desert Experimental Range. However, sheep

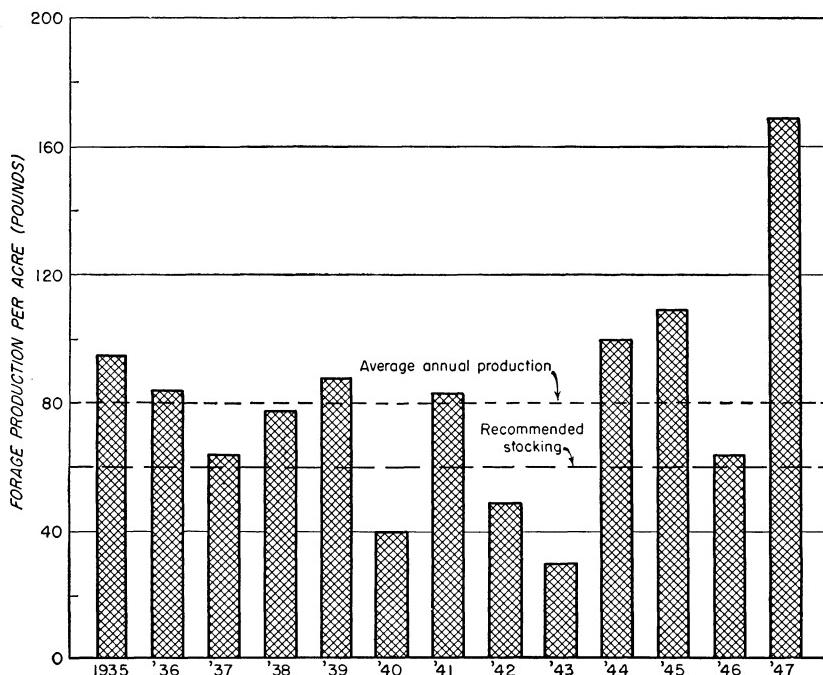


FIGURE 4.—Forage production on moderately grazed range areas at the Desert Experimental Range, 1935-47. Recommended stocking is based on 75 percent of average forage production which provides adequate forage except in years when production is extremely low.

on the winter range are primarily breeding ewes and winter grazing must be coordinated with spring-fall and summer grazing in the year-long operation and management of flocks. Therefore, sheep operations are not flexible enough to make the necessary adjustments in numbers to compensate for the variations in forage production.

Because of the normal inability to adjust sheep numbers to the wide variations in forage yield, basic stocking is recommended at 75 percent of average forage production. On this basis enough forage was available for the sheep during the period 1935-47 and no adjustments in stocking would have been necessary except in the drought years of 1940, 1942, and 1943. Judging from available records, supplemental feed or some adjustments in stocking on winter ranges will be required in 2 or 3 years out of every 10.

In years when forage production is good, utilization of the desirable forage species will be somewhat less than the amount listed on page 4, if the ranges are stocked at 75 percent of average production. The extra herbage left will help the plants recover from drought years and also help to build extra food reserves.

Severe droughts markedly lower the grazing capacity of winter ranges. During such periods total herbage production is often only a third to a half of average. Many of the species are weakened and heavy mortality of shadscale occurs. Effects of drought are often apparent on the range for 2 or 3 years. Light stocking may, therefore, be needed following severe drought. This is especially true on ranges where many of the desirable species are killed and injured by the combined effects of overgrazing and drought.

Fortunately most of the forage on winter ranges is produced before the winter grazing season begins. About 60 percent of the growth is made by the end of July and completed by September, almost a month before grazing starts. This gives stockmen an opportunity to examine the range, estimate forage available for winter, and make necessary arrangement to care for the sheep during winters when forage is short.

Good estimates of forage can be made by weighing the yields or measuring the length of growth of the various plants and comparing it with previous years' production. If possible, several areas should be examined each year to provide a good sample of the allotment. When it is not possible to examine the range, rough estimates of production can be made from precipitation records.

In general, amount of precipitation and total herbage production are closely associated on ranges of any one condition and type. In years when precipitation is high, herbage production is high; when precipitation is low or spotted, herbage production is likewise low or spotted. Yields in years of high rainfall have been as much as 6 times as great as yields in drought years.

At the Desert Experimental Range herbage production as measured in October was found to be closely related to the precipitation that was received during the preceding 12 months (October to September). Because of this close relationship the size of the forage crop that is available for winter grazing can be estimated rather accurately from rainfall by using figure 5. For example, if the precipitation for October to September is 7 inches, the approximate herbage production

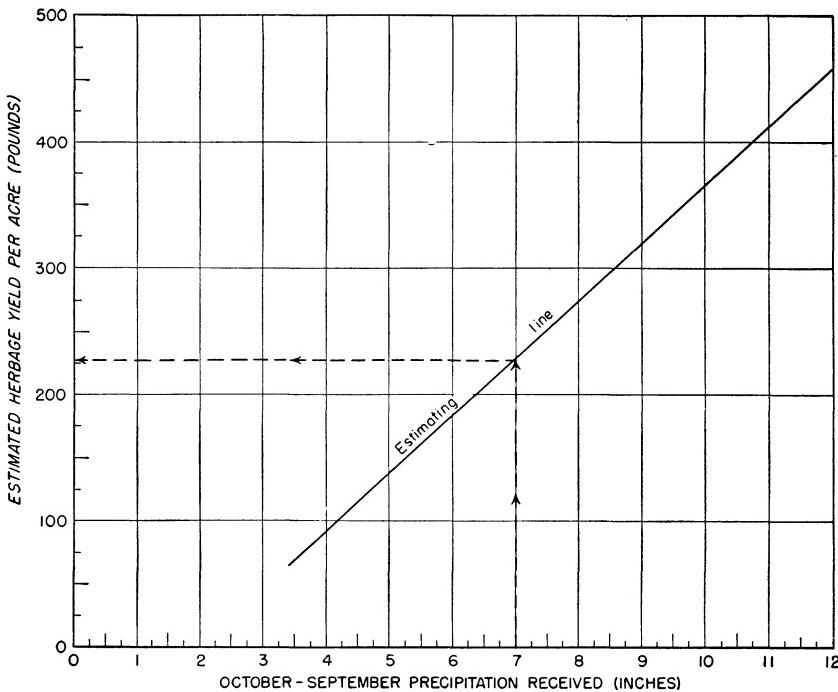


FIGURE 5.—Chart for estimating herbage yields in October (based on relation of October herbage yields to precipitation received during the preceding 12 months at the Desert Experimental Range).

on the range in October would be 230 pounds per acre. This can be read from the chart as illustrated by the dotted arrows. Find at the bottom 7 inches of precipitation and draw a line up to the estimating line. From this point draw a horizontal line over to the left side to get estimated herbage production.

From such an estimate of herbage production the sheepman can determine the available forage crop a month or two ahead of the grazing season. He then has ample time to make adjustments in stocking or to provide supplemental feed for anticipated short forage crops during emergency drought periods.

These data apply particularly well to nearby winter ranges similar to those of the Desert Experimental Range. They can also be applied to other ranges where the vegetation, condition of range, and amount of rainfall are similar. By making yearly observations the relation between precipitation and herbage yields could be developed to apply specifically to other range areas.

In years when a low forage crop has been produced the sheep operator can adjust stocking or provide supplemental feed by one of the following methods: (1) He may temporarily reduce the number of sheep in his flock by rigorous culling; this would tend to improve the quality of his herd. (2) He may provide and have on hand hay or other supplemental feed to use during the winter. (3) He may hold his lambs and older ewes on his home ranch and feed them throughout the winter. (4) He may purchase or lease range elsewhere.

Check on Forage Utilization

Periodic checks on the utilization of forage plants are essential in determining whether the range is properly grazed. They also provide a basis for making adjustments in grazing use.

Average utilization ratings, such as shown on page 4, established on properly grazed ranges and often referred to as "proper use factors," serve as standards or guides for proper grazing. These recommended ratings represent the average maximum allowable use of the desirable species and the use that less desirable species ordinarily receive when the desirable species are properly grazed (fig. 6).



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FIGURE 6.—Shadscale-winterfat range that is about properly grazed. The sheep have eaten the seeds and leaves of shadscale and taken about 50 to 60 percent of the winterfat herbage.

These recommended utilizations were obtained from grazing trials from 1934 to 1947 at the Desert Experimental Range. In these trials the best possible management, as explained in this bulletin, was given to the range. When the experimental range was established in 1934, most of it was in poor condition. The range improved to fair or good condition during the course of study, the better forage plants increasing in both size and number.

Twig lengths, stubble heights, and general characteristics of some of the better forage species on properly grazed range in an average year are presented below as guides for field use.

Indian ricegrass.—Indian ricegrass remains thrifty and vigorous when 25 percent of the current dried herbage is left at the end of the grazing season. All the plants of this highly palatable species are usually grazed to some degree and stubble height averages 2 to 3 inches. However, only the seed heads and finer leaves of the more robust plants are grazed and 5 to 6 inches of stubble is left on these plants.

Galleta.—About 55 percent of the galleta herbage is unused and from 1 to $1\frac{1}{2}$ inches of stubble remains at the end of the grazing season. Under this intensity of grazing about 5 to 10 percent of the grass area is unused. This usually consists of rank mature growth, which is often harsh and unpalatable. Also, a few scattered flower stalks within the grass clumps are ungrazed.

Salina wildrye.—About 55 percent of the Salina wildrye herbage is ungrazed and about $\frac{1}{2}$ to 1 inch of stubble is left on the basal leaves at the end of the grazing season. Usually about 15 to 20 percent of the grass area and numerous tall seed stalks are left unused at the end of the grazing season.

Black sagebrush.—At least 30 percent of the black sagebrush herbage production is left ungrazed; average length of current twig growth left ungrazed is $1\frac{1}{2}$ to $2\frac{1}{2}$ inches. Under this intensity of grazing 10 to 20 percent of the seed stalks in years when they are produced, will be ungrazed (fig. 7). All plants of this choice forage species show some degree of grazing use.

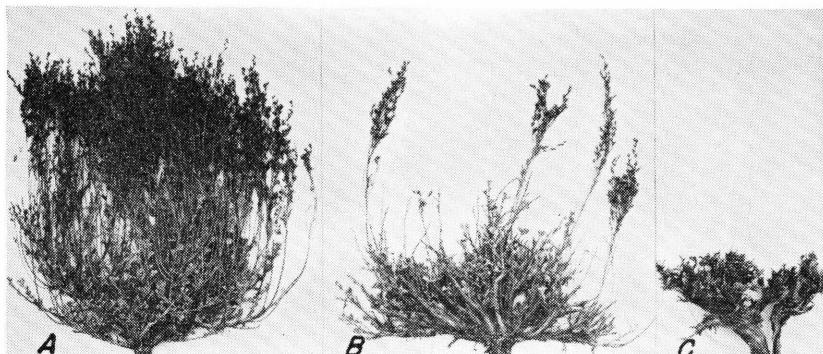


FIGURE 7.—Black sagebrush plants (A) ungrazed, (B) properly grazed, (C) heavily grazed.

Winterfat.—At least 40 percent of the winterfat herbage production is left ungrazed; average length of current twig growth left ungrazed is $1\frac{1}{2}$ to $2\frac{1}{2}$ inches (fig. 8). Some seed stalks will be left on many of the plants and 10 to 15 percent of the plants will appear to be ungrazed or only lightly utilized.

Bud sagebrush.—Proper utilization of bud sagebrush is difficult to describe because it is a low-growing species and usually only the stems are available as forage. In general, all plants will be utilized to some degree. About 50 percent of the total herbage will be unused and from $\frac{1}{2}$ to $\frac{3}{4}$ inch of current twig growth will remain at the end of the grazing season.

Gardner saltbush.—About 60 percent of the herbage on Gardner saltbush and 2 to 3 inches of twig growth are left ungrazed at the end of the season. Under this intensity of grazing 5 to 10 percent of the plants appear only lightly used and some flower stalks remain on many of the plants.

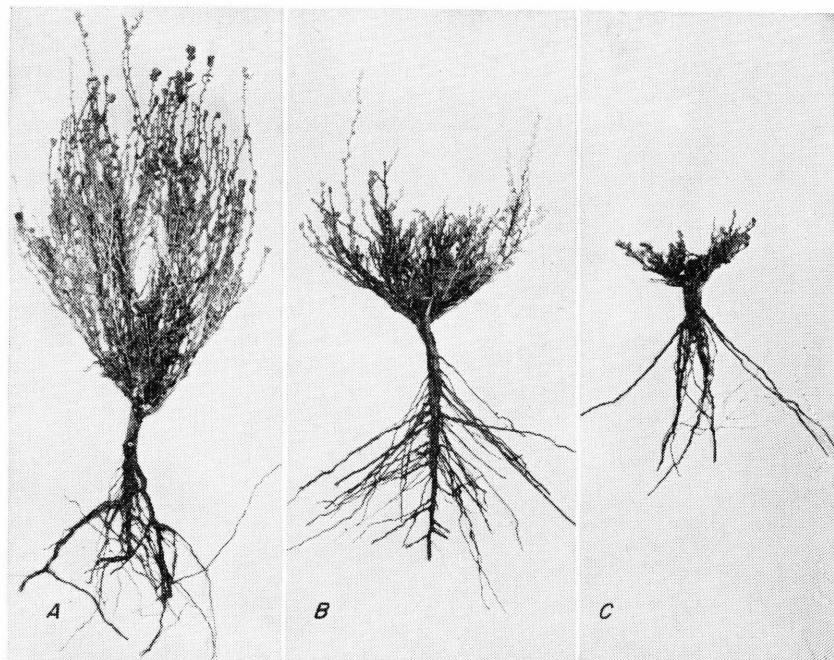


FIGURE 8.—Winterfat plants (*A*) ungrazed, (*B*) properly grazed, (*C*) heavily grazed.

On ranges in very poor condition a higher proportion of the herbage of palatable species needs to be left ungrazed. On severely depleted areas where the palatable species have been almost entirely destroyed, it may be necessary to eliminate grazing for 1 or 2 years or to graze lightly only every other year to obtain reasonable recovery.

Some reduction in utilization is also necessary in drought years, or on sandy areas where the soil and vegetation are likely to be injured by trampling. Under these conditions more herbage must be left to insure maintenance and production of the desirable forage species.

Condition of sheep using the winter range is also a good indication of whether the range is being properly grazed. If sheep have ample forage and remain in thrifty condition throughout the average winter, grazing is at about the right intensity.

GRAZE UNIFORMLY

Intensity of grazing on winter range is not always uniform. Inequalities in grazing intensity exist between broad regions. Inequalities are due to concentration of sheep near permanent watering places, near long-established bedding grounds, or on easily herded or choice forage areas. Still others are due to established practices in herding and handling the sheep on the range. To attain good range management such inequalities must be reduced or eliminated and the range grazed as uniformly as possible.

Divide Allotments Into Units

Most effective utilization of the forage can be obtained by dividing each individual allotment into three or four units. Then grazing can be controlled on each unit to allow the sheep some new ungrazed range every day, and the forage prorated for the entire winter period. Dividing allotments into units proved beneficial on the Desert Experimental Range. Sheep obtained adequate forage, grazed contentedly, and all parts of the range were used uniformly. They were not dependent on early spring growth during the late winter period or short, poor-quality forage on previously grazed range. Vegetation improved on all units throughout the period of the study. Some forage plants made more improvement on units grazed in early and middle winter than on those grazed in late winter. Late winter grazing reduced production of a few early-growing species such as bud sagebrush, Indian ricegrass, hopsage, and squirreltail. By alternating or rotating late winter grazing on the various range units, these detrimental effects were greatly reduced. The unit grazed in late winter one year was grazed in early winter or midwinter the following year. This made possible more uniform utilization, and those species which tend to be injured if grazed year after year in late winter were maintained in thrifty condition.

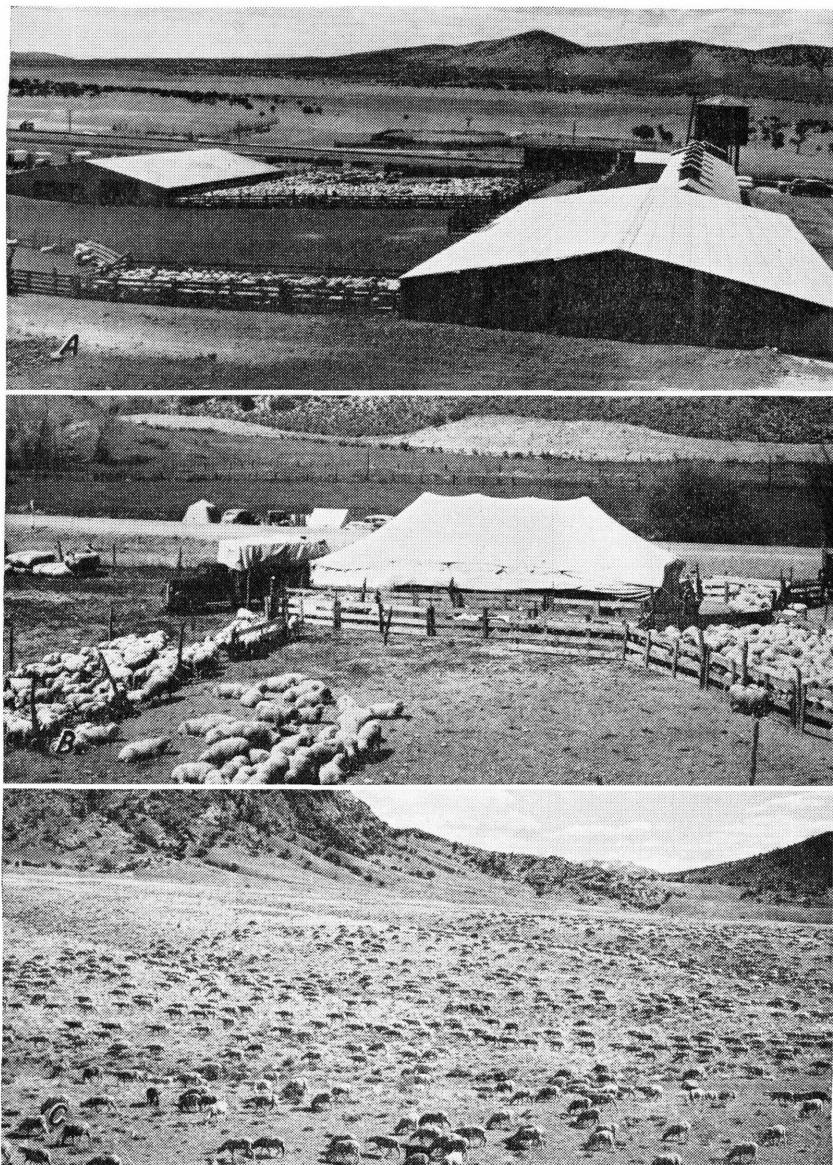
Under the individual allotment system each sheepman has a specified range to graze year after year. He knows how much forage he has each year, gives more attention to the range, and is assured of the benefits which come from better management. He can also provide for uniform grazing over the entire allotment.

Where the allotment is grazed as a single unit the entire range is "topped" as soon as the sheep reach the winter range and then grazed repeatedly throughout the winter. By March the allotment has usually been grazed over several times and the sheep are dependent on short, poor-quality forage for the remaining part of the winter. This is usually a critical period on most winter ranges. If spring growth starts early, some new plant growth is available in March. But if the season is late and growth is delayed until April, sheep are on short low-quality rations for 2 months or more.

When subdividing the allotments into units, parts should also be reserved for grazing during shearing. This is desirable because many flocks are now being shorn by itinerant shearers at portable corrals before they leave the winter range. The area reserved for shearing should have adequate forage, and good cover of juniper or sagebrush for protection to sheep during storms. It should also be readily accessible so that shearing equipment can be trucked in and wool can be loaded and hauled to the railroads (fig 9). The portable corrals can be placed in a new location each year and badly depleted areas around old corrals avoided.

Herd Carefully

Good herding and careful management of the flock are essential to proper grazing. Herding is a full-time job and a good herder spends most of his time with the flock, carefully checking the lead, directing the course of grazing, and allowing the sheep to graze quietly through-



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FIGURE 9.—*A*, A large centralized shearing corral on edge of winter range where 40 to 50 thousand sheep are shorn each year. Most palatable vegetation is destroyed for several miles around the corral and very little forage is available for the sheep. Death losses are often excessive at these large shearing corrals. *B*, Portable shearing corral made of canvas and wooden panels. One or two herds are shorn at each location. The corral can be located in a new place each year. *C*, Flock shorn at portable shearing corral before leaving winter range. Sheep have ready access to forage near the corrals.

out the day without excessive trailing. For good management the following herding practices are recommended: (1) Plan the routes of grazing to provide a variety of forage with some fresh ungrazed country every day; never, except in emergencies, round up the herd and trail to new areas; (2) allow the sheep to spread out and graze quietly, but do not allow them to trail back and forth across the range; (3) bed the flock in a new location each night wherever nightfall overtakes them; (4) if sheep are to be bedded in a special place, plan the day's grazing so the flock can graze quietly to the desired location by evening; and (5) avoid the use of dogs as much as possible.

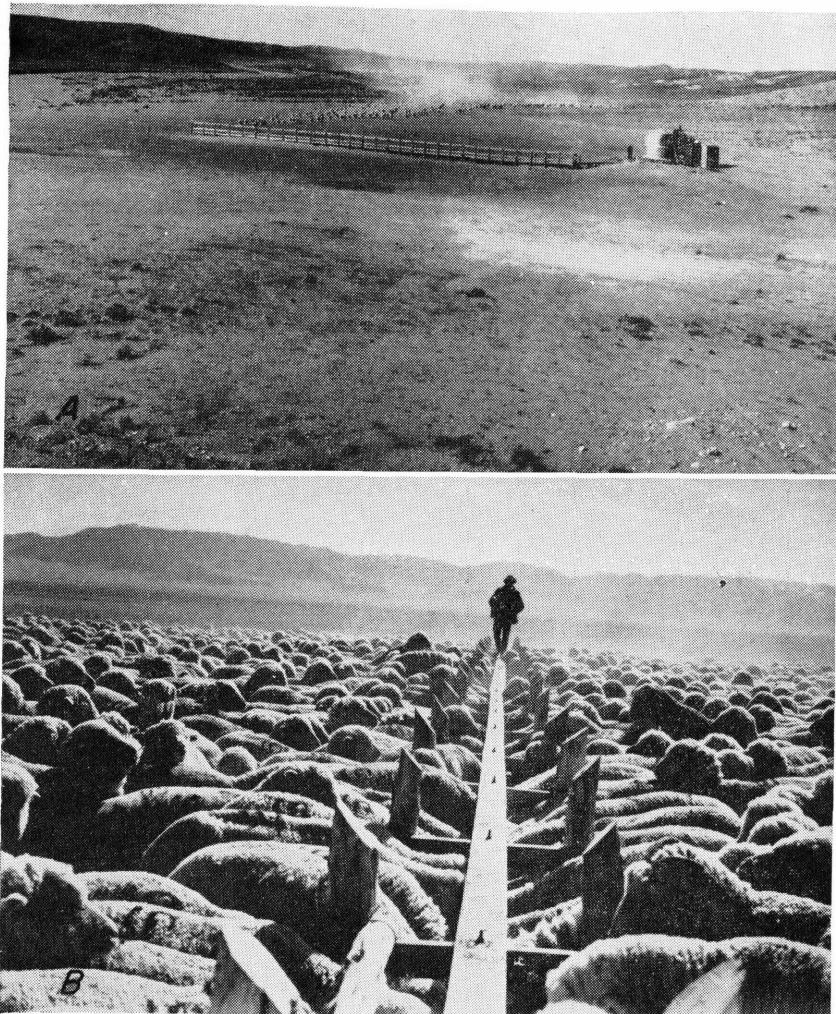
Several times through the winter the flocks must be corralled to segregate sheep or to shear the wool from around their eyes. Whenever the sheep are corralled, the herd should be allowed to graze leisurely to the desired location. Portable corrals, built on hard or somewhat gravelly ground to reduce the damage from trampling, should be used. Steel posts and lath snowfence have proved satisfactory for constructing corrals.

Provide Adequate Water

An adequate supply of good water for the sheep is essential. The amount needed depends on forage, snow, and weather conditions. Studies at the Desert Experimental Range show that sheep on winter range drink an average of 0.72 gallon per head per day. In warm weather in late winter they often drink 1.50 gallons, and if they are confined to dry forage such as shadscale, winterfat, or saltbush, they sometimes use as much as 2.20 gallons per head per day. Sheep do best if they receive water every day and if they are watered at a new location each time. It is often difficult, however, to supply adequate water on winter ranges because permanent watering places are sometimes 20 to 30 miles apart and watering facilities are inadequate to care for the needs of the sheep.

Snow is unreliable as a source of water. Frequently on the lower ranges, snow is not available in early and late winter. During these periods sheep are often trailed 3 to 5 miles to reservoirs, permanent springs or wells, or to higher areas where the snowbanks lie on north slopes and in canyons. After several trips into water or to higher areas for snow, the forage nearby is exhausted. The distance between forage and water becomes too great to travel every day or every second day so the sheep are then watered every third day (fig. 10). Under this treatment the sheep become extremely thirsty and the dry forage is unpalatable. No doubt lack of sufficient water contributes to malnutrition of sheep on winter ranges. In dry winters, such as those of 1934, 1946, and 1952, snow is lacking and large areas cannot be effectively grazed unless water is hauled to the sheep.

In recent years many reservoirs for catching and storing runoff have been developed on critical areas. Although in some years these provide additional water and result in better distribution of sheep, they are not always reliable because precipitation is often spotty and undependable. In an average year only 50 to 60 percent of the small reservoirs or tanks may be filled. In years of good rainfall most of them receive some water but in dry years only a few obtain water.

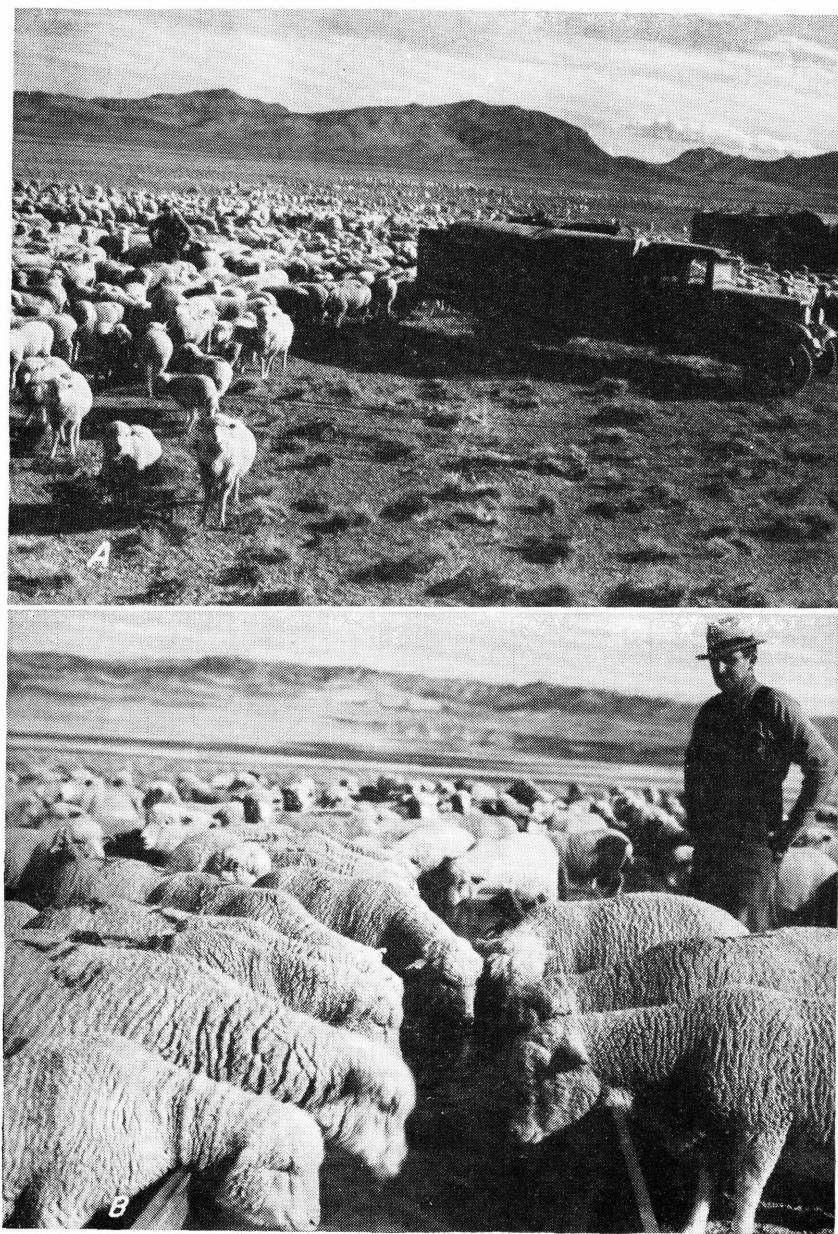


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FIGURE 10.—Trailing to permanent water is hard on both the range and sheep. *A*, A central well used by both local and trailing herds. Sheep are trailed long distances to water and the vegetation is destroyed on a large area around the well. *B*, Sheep often arrive at permanent wells gaunt and extremely thirsty. They crowd and jam against the trough and many overdrink.

Water in many of the reservoirs becomes brackish, dirty, and unpalatable and sheep do not drink sufficient quantities to satisfy their thirst. During years when water is available the surrounding range is often heavily grazed while remote areas are relatively lightly used.

Trucking water to the sheep has proved economical and profitable (fig. 11). On most areas water can be obtained from existing wells or springs and trucked to the sheep at desired locations. Most of the



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FIGURE 11.—Trucking water to sheep is beneficial to both range and sheep. Sheep obtain adequate clean water and the range can be uniformly grazed. A, Truck and tanks used for hauling water. B, Sheep drinking at troughs without crowding.

range can be uniformly and properly grazed, concentration at permanent watering places is eliminated, and long trails back and forth to water or snow are not necessary.

When the daily routes of grazing are planned and the water is placed ahead of the herd, the sheep graze quietly to water, drink, and are on fresh feed in a short time with a minimum of disturbance. They graze a greater variety of forage, especially the drier forage, and utilize the various species more uniformly than sheep which are allowed to become thirsty. As a result they remain in better condition. At the Desert Experimental Range sheep that received ample, fresh, clean water every day gained 3.4 pounds per head in 40 days while those which received water only every third day lost 6.0 pounds per head.

On many winter ranges water storage and loading facilities are often inadequate. At strategic pumped wells and seeps where the flow is small, storage tanks should be large enough to hold sufficient water to supply the sheep for several days. The tanks should be kept full so that adequate water will be available to carry the sheep over any periods during which the pump and equipment are being repaired or serviced.

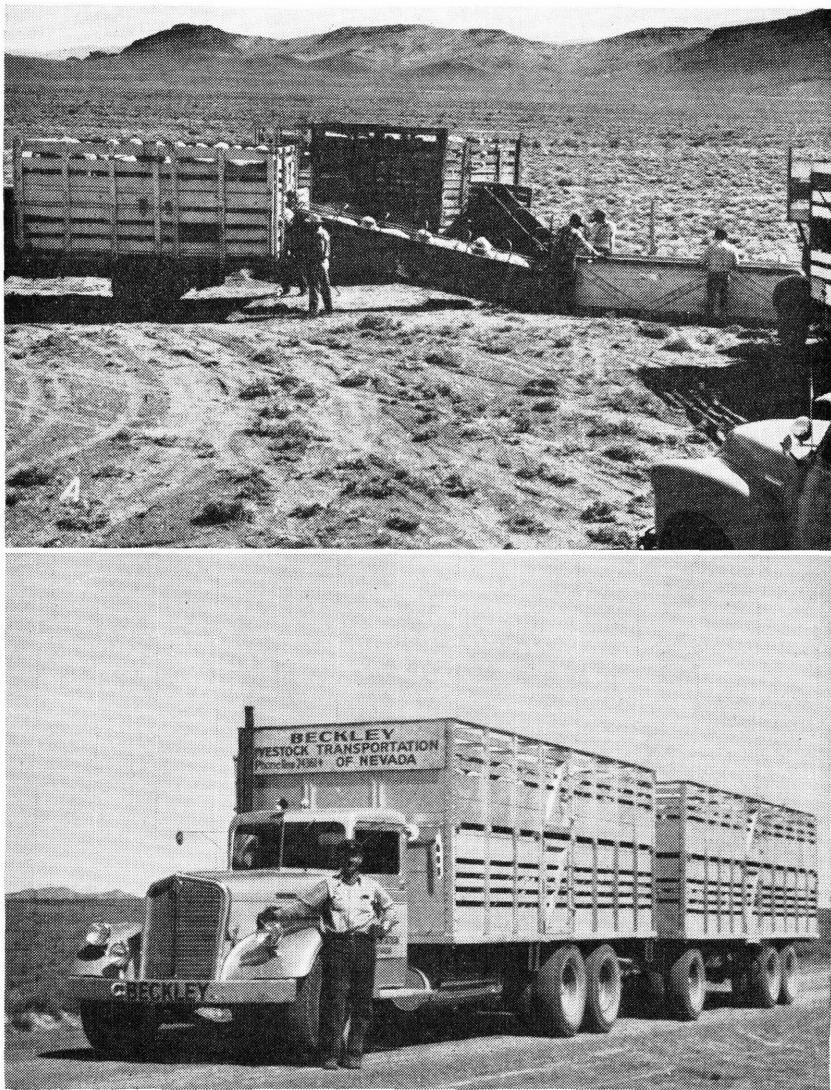
Stockmen who wish to obtain the greatest benefits from hauling water should adopt the following practices: (1) Water the sheep every day when snow is not readily available; (2) use good equipment and plenty of trough space to water the entire herd; (3) place the troughs well apart to allow the sheep to drink without crowding; (4) plan routes of grazing and place the troughs ahead of the herd so the sheep can graze quietly to water; (5) move the troughs to a new location after each watering.

PROVIDE GOOD MANAGEMENT ALONG SEASONAL TRAIL ROUTES

Trailing to and from the winter range is an important part of winter range management. Trail routes are located largely within the winter range area and much of the success of winter grazing depends on how well the sheep do along the trail. Most sheep are trailed to the winter ranges in October and November and return over essentially the same routes in April and May.

Trails are often 50 to 250 miles long, and the sheep require 5 to 25 days or more for each trip. Forage is often inadequate and is fully utilized by the first herds along the trail. Although sheep winter in good condition, many ewes often become poor and leg weary on the spring trail, especially those that are heavy with lamb. Thus benefits from good winter range management may be lost in trailing.

Hauling sheep to and from the winter range by truck or railroad should be done whenever possible (fig. 12). This will greatly reduce concentration along trail routes. On many areas no railroads parallel the trail routes, and many herds would have to be trailed considerable distances to and from shipping points. Therefore, trucking often is much more suitable, and trucking companies are now being developed to provide this service to the sheepmen.



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FIGURE 12.—Trucking sheep to and from the winter range is recommended.
A, small stock trucks and portable loading equipment are commonly used.
B, A large modern sheep pullman can haul from 200 to 300 sheep and operates best on good highways.

A truck and trailer or large semitrailer will accommodate approximately 200 head after they are shorn. Therefore, 10 to 15 trucks or trips are needed to transport a single herd. At present many roads to remote parts of the winter range are too rough for the

larger trucks. Improvement in loading equipment, construction of better roads, establishment of short trail routes to major highways, will all facilitate hauling.

The greatest benefits are obtained by hauling the sheep from the winter range in the spring, since the ewes heavy with lamb find it difficult to trail long distances. If sufficient trucks are available an entire flock can be loaded and trucked to the shearing corral or lambing range in one day. By this method sheep reach the spring lambing ranges in good condition and death losses are practically eliminated.

Widespread development of the trucking of sheep to or from winter range will alter present grazing and operational practices. Additional forage on spring-fall or winter range will be needed to care for the sheep during the time formerly needed for trailing.

Shipping or hauling sheep to and from winter range should be put into practice where possible. Where a trail route is used the following adjustments are recommended to provide good management: (1) Reorient grazing allotments to eliminate as far as possible crisscross trailing to and from winter range allotments; (2) relocate trails to the most suitable sites where forage and water are available in adequate quantities for the sheep using the trails; (3) limit the number of sheep using any given trail on the basis of available forage; this could be done by increasing the width of trails or by establishing new designated routes for each herd; (4) haul water to the herd along the trail; this can be done if adequate water is developed and loading facilities are provided; (5) provide hay or other feed along the trail where forage is inadequate; (6) establish a maximum as well as a minimum distance to be covered by trailing herds.

PROVIDE SUPPLEMENTAL FEED

On winter range supplements such as cottonseed cake, corn, or prepared grain and alfalfa pellets are often necessary to insure adequate nutrition, especially if the forage is immature or consists of low-quality forage species.

Chemical analysis of winter range forage plants and supplemental feeding trials indicate that many of the species are low in nutritional and mineral content. Grazing occurs while the plants are dormant and after the food reserves are translocated to the stems and roots. Phosphorus and protein are deficient in the dry grass herbage but high enough in shrubs such as black sagebrush, winterfat, and bud sagebrush to meet the minimum requirement of the sheep. Although specific studies have not been made to show that nutritional and mineral supplements are needed every year, supplemental feeding, if properly done, will probably be beneficial in most years to balance dietary deficiencies. This is especially so where grasses predominate or where desirable forage species have been replaced by undesirable ones such as sand dropseed, Russian-thistle, or small rabbitbrush. On these areas the nutritional quality of the forage is reduced and the need for supplements greatly increased.

The effect of grazing intensity on the need for supplements is illustrated by feeding tests made at the Desert Experimental Range in the winter of 1950-51. Ewes on heavily grazed range fed $\frac{1}{2}$ to 1

pound of prepared grain pellets every other day gained 4½ pounds per head; ewes on moderately grazed range, fed similar supplements, gained 13 pounds per head, almost three times as much as those on the heavily grazed range. Ewes that wintered on moderately grazed range, without supplemental feed, gained 6 pounds per head. The cost of the supplemental feed averaged \$2 per head during the winter.

Forage production on the winter ranges in 1950-51 was extremely short and herbage was dry because of drought during the growing season. The forage was apparently lower in nutritional quality than usual, because sheep on moderately grazed range gained less than in previous years. Low nutritional quality of the forage is also indicated by the 7-pound difference in weight gain between the ewes on moderately grazed range that received supplemental rations and those that received none.

The foregoing example also emphasizes that the use of supplements is not a substitute for proper grazing. Sheep fed supplements on heavily grazed range made 1½ pounds less gain per head than unsupplemented sheep on moderately grazed range.

With the wide fluctuations in precipitation and forage production, together with the likelihood of occasional heavy snowfall, frequent periods are encountered when forage is inadequate or snowfall is too deep to permit effective grazing. Severe winters occur rather frequently. During the winters of 1927-28, 1931-32, 1936-37, and 1948-49 deep snow and severe weather imperiled many sheep. Dramatic rescue efforts and the costly transportation of forage to the sheep were all that prevented disastrous loss in 1948-49. In many other years short periods with deep snow and cold weather occur, and the sheep suffer from lack of forage. During years of low forage production or periods of extreme weather, grazing hazards and losses can be greatly reduced by providing the sheep with supplements.

Some sheepmen feed supplements every year, others feed only for a short period in the late winter when forage is unusually scarce or during winter emergencies. As a rule, feeding should be started about January 15 and continued until March or April when new green forage becomes available. It is often desirable to continue feeding supplements along the spring trail or until the sheep reach the lambing ranges. When feeding is started only a small amount, usually $\frac{1}{8}$ pound or less per head per day, should be fed. The amount can be gradually increased to $\frac{1}{2}$ or 1 pound or more per head depending on forage condition and supplemental feed used.

In the fall before winter storms occur, supplemental feed should be purchased and hauled to the winter ranges and stored in steel rodent-proof granaries. Hay, which is difficult to haul and feed if the snow is deep, should be stored in a suitable place on the range.

CHECK GRAZING MANAGEMENT AND MAKE ADJUSTMENTS IN GRAZING USE

Examination of the range to check forage utilization and uniformity of grazing, range condition, and quality of herding is an important part of good management. If possible, the entire allotment should be examined each year and data recorded separately for the various

units. In years when this is not possible, key areas where grazing is most concentrated, such as choice parts of the range and those near water or bedding grounds, should be inspected. If these key areas are being properly grazed the less heavily grazed areas usually are not being injured. However, examination of the entire range can provide information on uniformity of grazing and distribution of livestock. By adjustments in grazing and elimination of undesirable grazing practices, fuller and better use of the range can often be obtained.

Checks on current forage utilization are needed to determine if the forage plants are being properly grazed. The average percentage of herbage utilization of the desirable forage species should be listed for various parts of the range and compared with the recommended standards. Two inspections are preferred. The first should be made well in advance of the end of the grazing season. This provides preliminary checks on utilization of forage and uniformity of grazing use. Also, estimates of the forage could be made to determine if enough was available for remainder of the grazing season. If necessary, adjustments in current grazing can be made to equalize grazing on the various units. The second inspection can best be made on each unit as soon as grazing is completed. Amount of utilization of the various species can be more accurately determined before the spring growth is tall enough to hide the old growth.

Careful checks on range condition year after year will provide information on whether the ranges are improving or declining. Increased vigor, production, or seedling establishment of desirable forage species accompanied by a reduction in the less desirable species and soil erosion indicate range improvement. Loss or deterioration in the desirable forage species and increase in seedlings and production of less desirable species indicate a downward trend.

When trends in range condition are being appraised allowance must be made for recent weather cycles. Many ranges show a general improvement with 1 or 2 years of favorable precipitation. Properly grazed ranges, if not in good condition, often show improvement in years of average or below-average rainfall. Ranges that decline during years of better-than-average rainfall need immediate corrective adjustments in grazing. All downward trends in range condition, even those in poor years, should be regarded as a warning of possible mismanagement.

The range should also be examined to check the quality of herd management. Inspection should reveal if the areas around watering places and bedding grounds are excessively used and whether the herd was allowed to trail back and forth across the range. On properly grazed ranges the bedding grounds and places where sheep water at portable troughs should be inconspicuous, and the vegetation around these areas should not be more heavily utilized than the rest of the range. Also, where shearing corrals are placed in a new location each year little if any of the area nearby need be permanently injured. Compaction of soil and formation of narrow paths through the vegetation indicate excessive trampling and trailing (fig. 13). These can be eliminated by better herding.

Adjustments to correct unsatisfactory grazing conditions should be made promptly. Poor distribution of the herd, unequal use of the



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FIGURE 13.—Excessive sheep trailing and trampling, as shown on this shadscale-winterfat range, compacts the soil, destroys seedlings, and leaves long trails and paths across the range. These characteristics of poor herding are easily recognized.

range, and excessive trailing usually can be corrected by better herding. However, on some ranges, water may need to be hauled, or additional water facilities provided. If the current utilization on the entire range is too heavy, a reduction can be obtained by grazing fewer sheep or by shortening the grazing season.

Continued good management and the benefits which are derived from it are possible only if the range is carefully examined and suitable adjustments made to provide for proper grazing year after year.

Successful application of good management and maximum benefits can be obtained through the combined wholehearted efforts and co-operation of land managers and stockmen.

BENEFITS FROM GOOD MANAGEMENT

On winter range many benefits are derived from application of the good management practices outlined above. Greater income is obtained, ranges are improved or maintained at near maximum production, sheep winter in good condition, and greater lamb and wool crops are produced. Death losses are smaller, supplemental feeding is reduced, and herding and management simplified. This is shown by studies on two allotments and detailed studies on 14 range pastures at the Desert Experimental Range.

To compare income and production, two full-sized winter herds of 2,500 to 3,000 sheep which were similar in breeding history and range operations were selected and placed on two large experimental allotments. In 1935, at the beginning of the experimental studies, the two allotments were similar and typical of the winter ranges with respect to topography, vegetation, and range conditions. Each of the two

allotments extended from the valley bottoms to the mountains. Both had been heavily grazed and they were classed as in poor condition.

During the period of study, 1935-43, a plan of management was applied to one allotment while the other was grazed without prescribed management. The two herds traded allotments every other year. This alternating arrangement was used to eliminate any differences between the herds and the carry-over effect, if any, of the previous year's grazing.

The plan of management on the first allotment was as follows: (1) The allotment was moderately stocked at an average rate of about 2.3 acres per sheep per month. The rate of stocking varied from 1.1 acres per sheep per month on the most productive black sagebrush and winterfat range to 6 acres per sheep per month on the poor sites in shadscale. Stocking was increased as the forage improved. (2) The allotment was divided into units which were grazed at prescribed periods. (3) Sheep were bedded in a new location each night. (4) Herding was carefully controlled to permit quiet grazing and to check unnecessary trailing. (5) Water was hauled to the herd every day or every second day when snow was not readily available.

The unmanaged allotment was grazed as follows: (1) Stocking was heavy. Exact figures are not available because the allotment was grazed in common by several bands of sheep during the first 4 years. However, it is estimated that the initial stocking was approximately 30 percent greater than that on the managed range. Average stocking rate for the entire period was probably 20 to 25 percent greater, and current average stocking rates are now only about 5 to 10 percent greater than on the managed range. The increase in stocking was made possible through improvement in vegetation on the managed range. (2) The entire allotment was used as a single unit and was grazed repeatedly during the winter. (3) The sheep were bedded on established bedgrounds, and often trailed 3 to 5 miles to reach a particular old bedground. (4) Trailing and movement of sheep were seldom checked. (5) The sheep were primarily dependent on snow or permanent springs and were often trailed 3 to 4 miles to water or snow. During dry periods in early and late winter when snow was not available sheep often received water only every second or third day.

Detailed studies were made in a series of 14 large range pastures to measure the effects of grazing intensity on forage yields and sheep production. Seven pastures were moderately grazed and stocked at the average rate of about 2.5 acres per sheep per month and 7 were heavily grazed and stocked at about 1.8 acres per sheep per month. The numbers grazed were adjusted each year on the basis of October herbage yields. This was done to maintain fairly uniform utilization of the forage from year to year. Vegetation in the pastures consisted chiefly of winterfat, shadscale, sand dropseed, galleta, and bud sagebrush. Herbage yields, forage utilization, and sheep weights were recorded each year.

Sheep in all pastures were allowed to graze freely without herding. They had access to snow or water every day. When snow was not available water was hauled to the pastures and placed in troughs. During cold weather, ice that formed on the troughs was broken and

removed. Sheep were bedded in different parts of the pastures from time to time and troughs were moved frequently to aid in obtaining uniform grazing.

GREATER INCOME

The application of good management practices described in this bulletin resulted in greater income to the sheep operator. Comparison of income from the two bands of sheep which grazed the two allotments under different management conditions illustrates this. Average net income from the herd of 3,000 ewes on the range where good management was practiced was \$10,380; income from the herd on poorly managed range was \$5,072. Average production and income from the two herds, computed on the basis of 3,000 ewes, on winter range under good and poor management is given for the period 1935-43 as follows:

	<i>Good management</i>	<i>Poor management</i>
Breeding ewes-----	number 2, 610	2, 550
Ewes sold-----	do 297	207
Lamb crop-----	do 2, 297	2, 015
Lambs held-----	do 390	450
Lambs sold-----	do 1, 907	1, 565
Weight of lambs sold-----	pounds 143, 025	109, 550
Sale price per pound-----	dollars 0. 085	0. 08
Ewes sheared-----	number 2, 953	2, 878
Fleece weight-----	pounds 10	9
Wool produced-----	do 29, 530	25, 902
Income:		
Ewes sold-----	\$891. 00	\$621. 00
Lambs sold-----	\$12, 157. 13	\$8, 764. 00
Wool ¹ -----	\$10, 335. 50	\$9, 065. 70
Pelts-----	\$46. 50	\$121. 50
Gross income-----	\$23, 430. 13	\$18, 572. 20
Costs ² -----	\$13, 050. 00	\$13, 500. 00
Net income-----	\$10, 380. 13	\$5, 072. 20

¹ Sale price of wocl \$0.35 per pound.

² All operating costs, including taxes, replacements, labor, feed, and miscellaneous.

The net income per ewe from range under good management was \$3.46. This was more than twice as great as the net income of \$1.69 from range under poor management. Different prices and operational costs may alter the income, but would be proportionate to the values given. For example, net income per ewe was almost twice as great in 1952 as for the period 1935-43. Therefore on the basis of 1952 income, net returns per ewe under good management would have been approximately \$6.92 as compared to \$3.38 under poor management.

Income per acre was also greater on the well-managed range. The greater net income obtained under good management was directly attributable to increased forage production, better condition of sheep, greater lamb crops, greater wool production, lower death losses, less supplemental feeding, and more ease in handling sheep. These tangible benefits are described below.

GREATER FORAGE PRODUCTION

Good grazing management will improve forage production on range in fair or poor condition and it will maintain production on range now in good condition. On the Desert Experimental Range, which was initially in poor condition, good management greatly increased yields of total forage.

Winterfat, the most abundant palatable species on the experimental pastures, showed a marked upward trend in production from 1935-47 under moderate grazing but declined slightly under heavy grazing (fig. 14). At the beginning of the study heavily grazed pastures produced 43 pounds more winterfat per acre than the moderately grazed ones, but by 1939, 4 years later, yields had improved under moderate grazing enough to equalize the initial differences in production. Winterfat continued to increase slowly on the moderately grazed pastures and by 1947 the yield was 10 pounds per acre greater than on the heavily grazed pastures. Differences in winterfat production were much greater in years with good precipitation than in drought years. Winterfat yields increased rather rapidly at first but as the range improved and the competition between species increased, improvement was much slower.

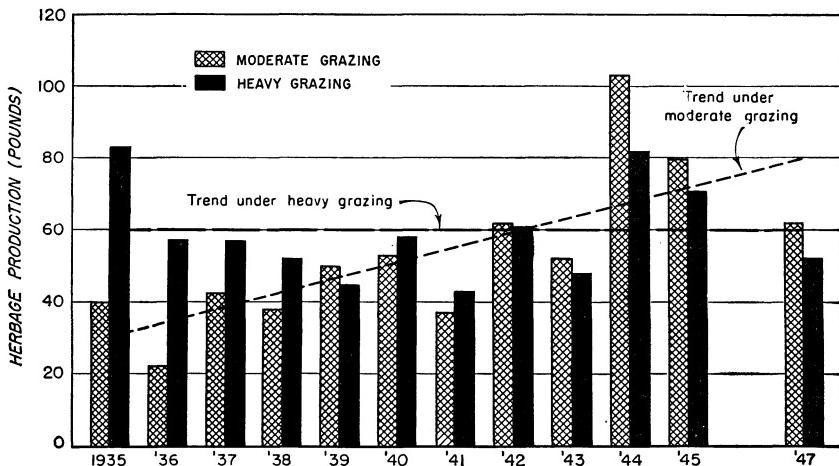


FIGURE 14.—Production trend and average annual yield of winterfat herbage, adjusted for variations in precipitation, on moderately and heavily grazed pasture at the Desert Experimental Range, 1935-47.

Under good management the vegetation on the moderately grazed pastures and on range allotments in poor condition improved in production and forage quality. During the first few years most of the improvement came from increased vigor of plants already established. Later as the plants increased in vigor new seedlings of desirable forage species became established and gradually replaced some of the less desirable species. Range recovery which came from the establishment of new seedlings was slow but over a period of years the vegetation improved greatly in forage quality.

For example, in 1934 a large area of black sagebrush-winterfat range in poor condition was divided and a part of the area was placed under good management, while the other part was poorly managed. Vegetation on both parts was similar. The desirable forage species, black sagebrush, winterfat, Indian ricegrass, and squirreltail, were all heavily grazed and in poor condition. The less desirable species, small rabbitbrush and Russian-thistle, were thrifty and vigorous and most of the young plants were of these species.

Herbage production in 1934 was essentially the same on both areas (fig. 15). Although subsequent yields varied with precipitation, total herbage production under good management was 20 to 30 percent greater than that on the poorly managed area.

On the well-managed range all desirable forage species increased. Black sagebrush, the most choice forage species, made the greatest recovery. This highly palatable species produced only 21 pounds per acre, 7 percent of the total herbage, in 1934. In 1947, with good rainfall it produced 295 pounds per acre; in 1952, with low precipitation, yield was 164 pounds per acre. Much of the increase came from the establishment and growth of new plants. With this improvement, black sagebrush became the most productive and important forage species on the well-managed range, accounting for 44 percent of the total herbage and 47 percent of the usable forage.

Estimated usable forage following 1938 was more than twice as great on the area under good management as on the poorly managed area. In addition, because of the increase in black sagebrush and winterfat which are high in protein and phosphorus, the nutritional quality of the forage was improved.

The undesirable forage species all decreased under good management. Russian-thistle which has invaded many deteriorated ranges, especially the winterfat areas in the bottoms of the valleys, was

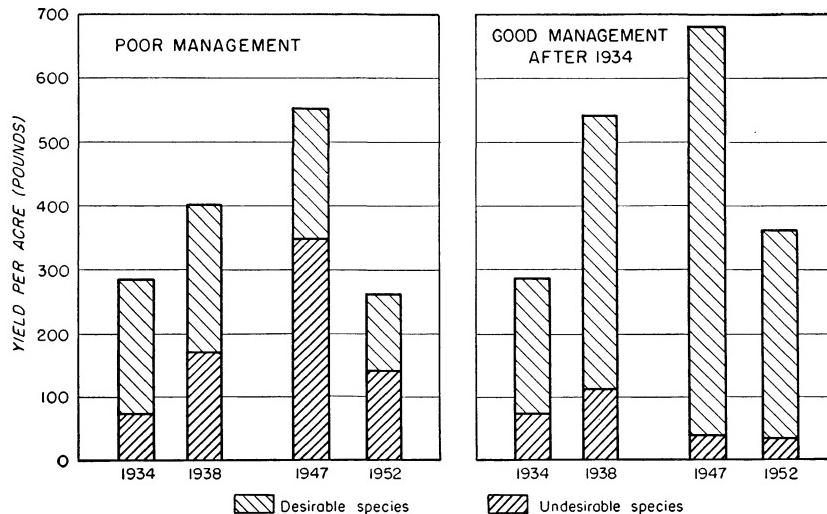


FIGURE 15.—Herbage yield of desirable and undesirable forage species on black sagebrush-winterfat range under good and poor management.

quickly replaced by desirable forage species on moderately grazed range. One of the chief characteristics of Russian-thistle is that it cannot compete with the native vegetation. When the choice forage species are thrifty and vigorous, there is little, if any, Russian-thistle on the range.

In contrast, all the desirable species decreased on the poorly managed range; black sagebrush remained a very minor species and produced in 1952 only 10 pounds per acre, which was 4 percent of the total herbage. The undesirable species increased greatly. Small rabbitbrush, which often invades deteriorated ranges, produced only 4 percent of the total herbage in 1934, but accounted for 33 percent in 1952.

Fortunately, many of the desirable forage species are better adapted to the winter range areas than the less desirable forage species. If the ranges are properly managed, nature helps to rebuild the range with productive, palatable forage species.

In addition to the improvement in forage, herbage yields become more stabilized under good management. The perennial native forage species fluctuate less with precipitation and produce much greater quantities of forage in drought years than the annual Russian-thistle. On some winterfat ranges in poor condition, yields of Russian-thistle have varied from zero to 500 pounds depending on precipitation. On similar soil types native vegetation in good condition is composed largely of winterfat and Indian ricegrass. Yields in these species varied from 120 to 430 pounds per acre, providing much more reliable forage, especially in drought years.

Good management also stimulates seed production of desirable forage species. The increase in seed often exceeds, in proportion, the increase in herbage production. Seeds produced by the vigorous plants are better filled than those produced by weakened plants.

On poorly managed range large quantities of seed produced by undesirable forage species are left to reseed the range while sheep readily eat the meager crop produced by weakened desirable species.

Good seed crops are produced only in years of favorable rainfall. These are infrequent and occur only in about 3 out of every 10 years. Good seed crops of winterfat and Indian ricegrass occurred at the Desert Experimental Range in 1937, 1941, and 1947, but good seed crops of shadscale occurred more frequently. In some drought years no seed is produced by any of the winter range plants.

Seedlings of desirable forage species are produced only in favorable years when precipitation is timely and sufficient to germinate the seed. The best seedlings are obtained when a good seed year is followed by a year with favorable precipitation.

On well-managed range the environment for young forage plants is greatly improved. The increased plant cover and additional top growth produced by the older plants provide protection against exposure and dry winds. Trampling by sheep and soil movement, both of which destroy many seedlings, are greatly reduced. Even under the best conditions, however, seedling mortality is high. Because of the infrequent seed production it is important to have the ranges properly grazed to insure adequate production and survival of seedlings of the desirable forage species.

BETTER SHEEP CONDITION

Ewes kept throughout the winter on moderately grazed range were maintained in 5 to 15 pounds better flesh than those on heavily grazed areas, according to a 6-year study. The average increase under moderate grazing for the 6-year period was 11.4 pounds per head (fig. 16). Sheep on heavily grazed range showed a slight loss.

Over a period of 6 years, 1938-44, two groups of ewes from 1 to 6 years old were grazed in experimental range pastures. One group was carried through the winter on moderately grazed pastures and the other group on heavily grazed ones. The grazing period was arbitrarily divided into three periods; early winter, midwinter, and late winter. Sheep were placed in early winter pastures about November 15, transferred to midwinter ones about January 5, and to late winter ones about February 23 where they remained until about April 10. All sheep were weighed at the beginning and end of each period.

During early and midwinter periods sheep on heavily grazed range lost while those on moderately grazed range gained. During the late winter period all sheep made some gains. This is probably due to two factors: (1) The late winter period coincides with early growth of the forage plants which furnishes ample nutritious forage, and (2) the ewes, which are bred in December, are putting on weight because of the fetal development in the late pregnancy period.

Generally, winter ranges furnish only a maintenance ration for the sheep because much of the forage, especially the grass, is dry and low in protein and other nutrients. In winters following good forage production the animals subsist fairly well and though they may lose some weight they are still thrifty when they leave the winter range in the spring. The ewes, many of which were pregnant, that were

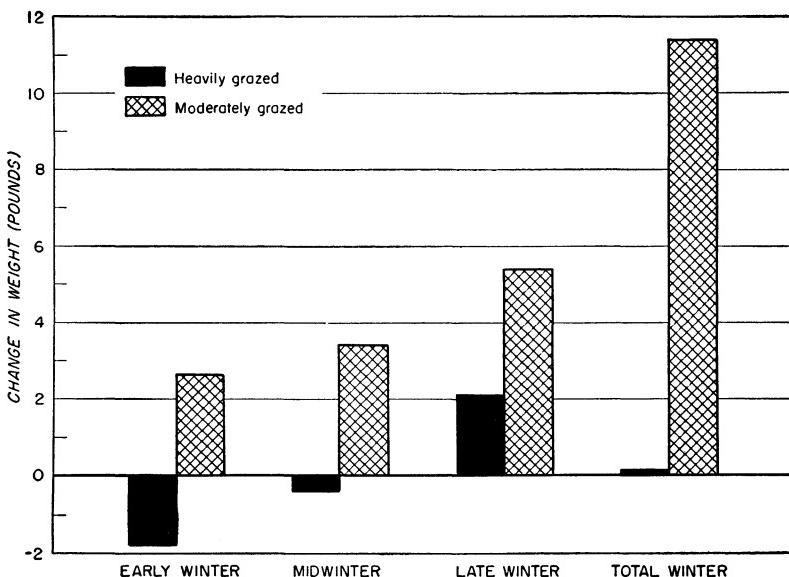


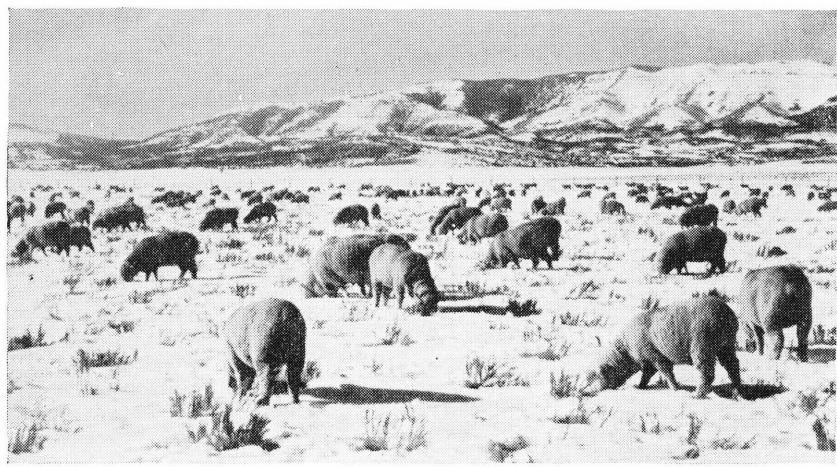
FIGURE 16.—Change in body weight of sheep on heavily and moderately grazed range pastures at the Desert Experimental Range, 1938-44.

carried through the three winter periods on heavily grazed areas lost weight and were in very poor condition by spring. Gain or loss in body weight of sheep for various winter periods is influenced by the initial condition of the animals at the beginning of each period. Sheep which had become very poor on heavily grazed pastures often failed to improve even though they were placed on moderately grazed range.

Differences in the kind and amount of herbage produced also influenced sheep weights. Sheep on range where the vegetation was predominantly grass and shadscale gained less than those on range where winterfat made up a considerable portion of the herbage. Sheep made the best gains on range where black sagebrush, winterfat, Indian ricegrass, and bud sagebrush produced 30 percent or more of the forage (fig. 17).

The weights indicated in figure 16 do not represent net body weights. Ewes weighed in the spring bear about 4 to 5 pounds more wool than in the fall. Many are carrying lambs which, together with fetal tissue and liquid, weigh 10 to 15 pounds. Thus pregnant ewes that weigh the same in spring as they did when they reached the winter range in the fall have decreased 15 to 20 pounds in body weight when deductions are made for current wool growth and unborn lambs. In some years, even under moderate grazing where the sheep have ample forage, there is considerable decrease in body weight of the ewes.

In years when forage is poor and weather cold, ewes begin to lose weight immediately. The lowest ebb in body weight occurs in January on moderately grazed range. On heavily grazed range sheep continue to lose flesh until March or until spring growth of forage begins. At this time, sheep on moderately grazed areas often show a loss of several pounds in body weight. Many on heavily grazed ranges show a loss of as much as 6 to 14 pounds.



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FIGURE 17.—Sheep on moderately grazed black sagebrush range at the Desert Experimental Range. The nutritious sagebrush plants extend above the snow and furnish excellent forage. Sheep on this range are maintained in good condition.

The effect of loss in body weight, especially if the ewes become very poor, is reflected directly in higher death loss, lower lamb crop, lower production and poorer quality of wool, and increased feeding costs.

HIGHER LAMB CROP

More forage and better winter condition of ewes brought about higher lamb crops. The herds which wintered on well-managed range produced 88 lambs per 100 ewes while those on poorly managed range produced only 79. This is an average of 11 percent greater lamb crop. On the well-managed range where the sheep obtained adequate forage the ewes were maintained in good flesh during the breeding season, in December and January. This resulted in higher fertility of the breeding ewes.

At lambing time in May, immediately following the winter grazing period, ewes from the well-managed range were in good condition and had adequate milk for the lambs. Probably because the lambs were better fed during the first few weeks after birth they were slightly heavier at market time in the fall.

Many ewes which became weak and thin on the poorly managed range refused to claim and care for the lambs when they were born. Others did not produce enough milk to nourish them properly.

SMALLER DEATH LOSSES

More forage and better winter condition of ewes also resulted in smaller death loss. A death loss of only 3.1 percent occurred on the well-managed range; two-thirds of these were killed by coyotes and a few animals were lost by straying. Such losses are kept to a minimum by alert herding. Losses from malnutrition were practically eliminated.

Death losses on the poorly managed range averaged 8.1 percent— $2\frac{1}{2}$ times that under good management. Occasionally in winters of short feed, especially when the weather was cold and snow deep, the sheep became poor and weak and losses were heavy. For example, in the winter of 1931-32, on poorly managed, heavily grazed range, losses of 10 to 20 percent were common and in a few herds losses of 30 to 50 percent occurred.

In January 1937 and again in January 1952, when deep snow covered many of the winter ranges, losses were heavy on poorly managed range. However, under these extreme weather conditions losses from malnutrition and cold were much smaller and largely prevented on the well-managed range.

LESS SUPPLEMENTAL FEEDING

Except in years of low forage production or during severe storms or bad weather little, if any, supplemental feed is required to maintain sheep in fairly good condition throughout the winter when ranges are properly managed and the forage plants are in thrifty vigorous condition.

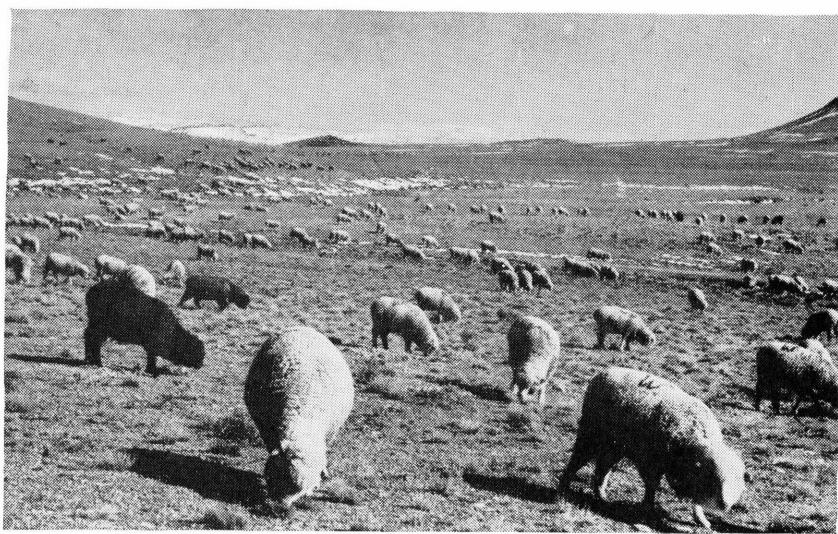
During periods when forage is short and inadequate many sheep, especially those on heavily grazed range, are fed approximately $\frac{1}{8}$ to 1 pound per head daily of cottonseed cake, corn, or prepared grain pellets to prevent heavy losses. It has been necessary to feed sheep

on heavily grazed range considerable amounts of cottonseed cake or corn during 3, 4, or 5 out of the past 10 years. Some flocks were fed supplements throughout the winter while others were given supplements only during a short time in the late winter and early spring in years when forage was unusually scarce. The amount fed and the length of the feeding period depend primarily on the forage supply and weather conditions.

EASIER HERDING AND OPERATION

Many of the problems encountered in operating sheep on winter range are greatly simplified if the ranges are well managed. The sheep obtain ample water and graze quietly. They travel relatively short distances in search of forage. Because they use up less food energy in obtaining forage and water, the sheep have more to use in growing wool, maintaining body weight, and producing lamb. On poorly managed range the sheep travel long distances to obtain forage and often the supply is inadequate. Generally this excessive trailing uses up a lot of energy and also increases the need for water.

Problems and difficulties in caring for the sheep are also reduced by good management. It is often necessary to provide supplemental feed for the sheep that become weak on heavily grazed and poorly managed range. In many cases the weakened animals are trucked to the home ranches 100 or 150 miles away. The cost of 3 or 4 trips with a truck, the extra feed used, and the work required to care for the poor sheep greatly adds to the operation costs. On properly managed range, the sheep remain in good condition (fig. 18).



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FIGURE 18.—Typical black and bud sagebrush on the Desert Experimental Range. The scant vegetation furnishes excellent forage. During the late winter periods sheep obtain water from the patches of snow. The range is moderately grazed and the sheep are in excellent condition.

IMPORTANT WINTER RANGE PLANTS

Winterfat (fig. 19), known to many stockmen as whitesage, is a low, silvery-white shrub which grows 10 to 15 inches high. New stems are produced each year from the basal portion of the previous year's stems and from the woody crown of the plants. New growth averages 3 to 10 inches in height and is covered with a mat of silvery-white hairs. New spring growth is greenish white but on maturity the green color is lost and the plants become characteristically silvery white. Good seed crops are produced only at irregular intervals in years when precipitation is favorable. The seeds will germinate and grow as soon as they mature, but quickly lose their viability. Less than 20 percent of the seeds will grow after 1 year's storage.

Winterfat probably produces more forage on the winter range than any other species because it is relatively abundant and readily eaten. It is often injured or killed by heavy grazing and replaced by small rabbitbrush, Russian-thistle, halogeton, or other poor forage species. Winterfat commonly occurs in fairly dense pure stands and covers large areas along the broad, flat drainages and lower valley slopes where the soil is fine in texture and fairly alkaline.

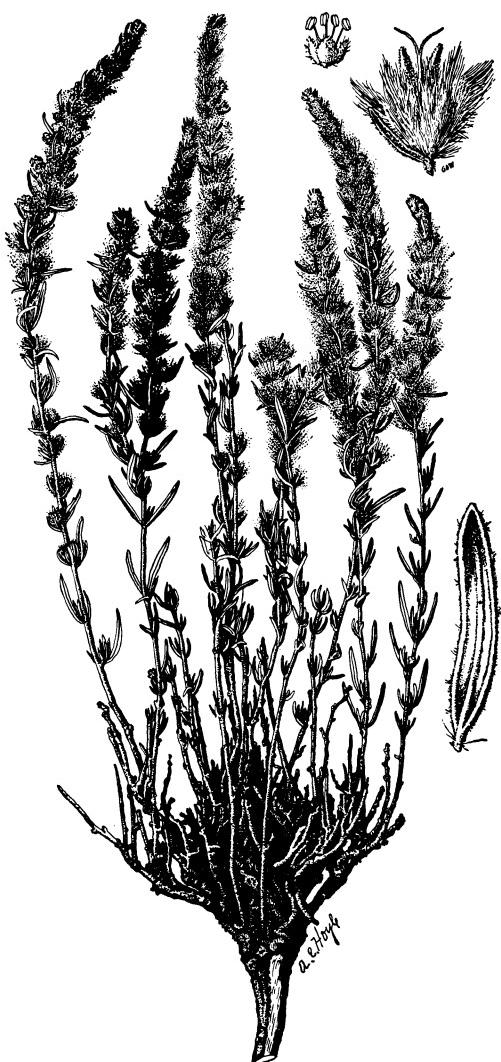


FIGURE 19.—Winterfat (*Eurotia lanata*).

Black sagebrush (fig. 20), a low shrub, 1 to 2½ feet high, begins to grow in April or May. The habit of growth and characteristics of the plant are similar in many ways to big sagebrush, of which some botanists consider it to be a variety. The leaves are greenish gray, divided at the end into three short fingerlike lobes or points. They are not as silvery as those of big sagebrush and the plants are not as large. The inconspicuous greenish yellow flowers, which appear in the late fall, are borne in small heads loosely arranged along the seed stalks. The seed stalks are smooth and hairless and brown when mature.

Black sagebrush is probably the most palatable and nutritious plant on the winter range. The herbage is rich in protein and phosphorus. It is readily eaten by sheep throughout the winter and seems to be especially desirable during cold snowy periods in January and February. Because of its high palatability black sagebrush is often heavily grazed, badly hedged, and in many cases destroyed. On many such range areas it has been replaced by small rabbitbrush.

Under moderate grazing black sagebrush rapidly improves and slowly replaces small rabbitbrush and other undesirable forage species.



FIGURE 20.—Black sagebrush (*Artemesia nova*).

Bud sagebrush (fig. 21) is a low spiny shrub 3 to 12 inches high with small and finely divided leaves. Growth begins early in March or April as soon as the weather becomes warm. The new growth of leaves forms a dense green cover over the spines. The tiny yellow flowers, in small budlike clusters, are produced in May. During the summer the leaves turn brown and fall to the ground and the plant appears dead. In winter the short spiny stems do not have any foliage but are covered between the buds with short white hair.

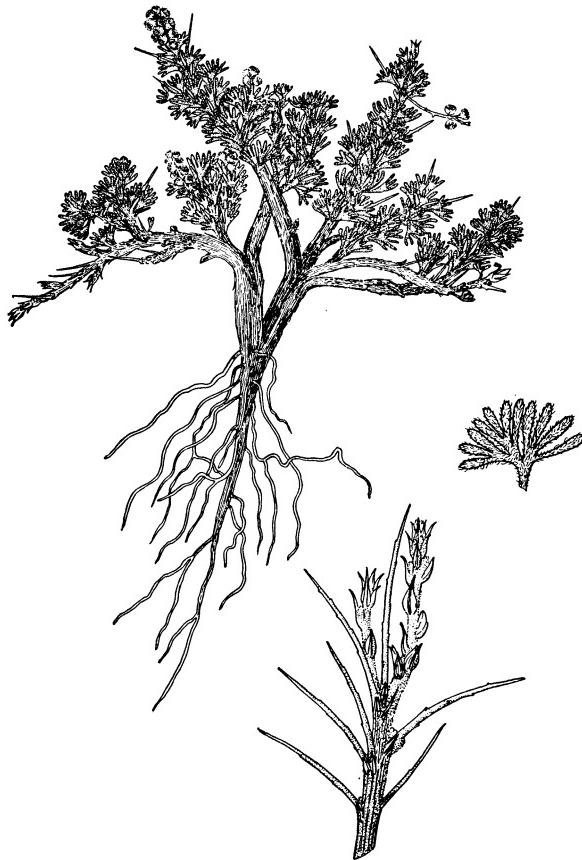


FIGURE 21.—Bud sagebrush (*Artemesia spinescens*).

Bud sagebrush ordinarily grows on the less alkaline soils in mixed stands with winterfat, shadscale, or black sagebrush. In a few areas in central Nevada it forms rather extensive, almost pure stands.

Bud sagebrush is one of the most palatable sheep forages on the winter range. It is grazed throughout the winter but is most highly relished during the late winter period when the bark and tender buds are stripped from the twigs. On many ranges bud sagebrush is closely cropped and appears hedged, especially on areas that are grazed in the late winter period every year. Because of its high palatability bud sagebrush is one of the first plants to be injured and destroyed by heavy grazing.

Gardner saltbush (fig. 22) is a low grayish or whitish, narrow-leaved shrub which grows 1 to 2 feet high. It is often called salt-sage or Castle Valley clover. The basal portions are woody and the branches often spread along the ground. New growth each year is produced from the woody basal stems. The flowers are inconspicuous but the seed is produced in large quantities along the upper branches. The seeds are rough and nutlike, about $\frac{1}{8}$ inch across the broader end.



FIGURE 22.—Gardner saltbush (*Atriplex gardneri*).

Gardner saltbush grows on clay soils in the valley bottoms which are strongly alkaline. It covers extensive areas on the flat clay soils where free water sometimes accumulates temporarily. The most extensive stands are found in Colorado, Utah, and Wyoming. It is often mixed with mat saltbush and occasionally with seepweed and grease-wood.

Gardner saltbush is readily eaten by sheep and is fairly nutritious especially when the seed and seed stalks are available. Approximately 40 percent of the herbage is utilized when the range is moderately grazed.

Shadscale (fig. 23), often called spiny saltbush, is a compact, low shrub 8 to 24 inches high. It grows in individual clumps or bushes, but sometimes forms dense, almost solid clumps 8 to 10 feet in diameter. The base of the plants and stems is woody and the stems are spine-tipped. The thick leaves and seed bracts densely cover the stems. Shadscale is grayish green during the growing season but takes on a reddish purple autumn coloration. In the wintertime the plants turn grayish brown. Shadscale grows in pure stands on the lower valley areas where the soil is fine and rather heavily alkaline. It also grows on the alluvial slopes intermixed with winterfat, galleta, and bud sagebrush.

Shadscale is one of the most important native species on the winter range. The leaves and seeds are readily eaten by sheep, but the harsh stems are not eaten much because they are protected by woody spines. Therefore this species often invades or increases on overgrazed range when the other more palatable vegetation is destroyed or injured. Prolonged drought causes heavy mortality of shadscale.



FIGURE 23.—Shadscale (*Atriplex confertifolia*).

Small rabbitbrush (fig. 24) is a low, compact shrub 8 to 15 inches high. The plant begins to grow in April and May and new shoots are produced from the woody base of the old stems. The new twigs are green but as they mature they become shiny white. The stems are fine and the leaves very narrow, $\frac{1}{16}$ inch wide, about 1 inch long, and often somewhat twisted. In August the plant produces a mass of tiny yellow flowers at the ends of the branches. The flowers are borne in small clusters with 3 to 5 flowers in each head. Each flower has a ring of long whitish hairs attached to the top of the tiny seeds.

Small rabbitbrush grows most abundantly in mixed stands with Indian ricegrass, on the loose sandy soils. However, it has invaded many of the better sites on the black sagebrush and winterfat ranges where the desirable forage species have been injured or reduced by grazing. The presence of small rabbitbrush in noticeable quantities on winterfat and black sagebrush range probably indicates that these areas are in deteriorated condition. When grazing is reduced small rabbitbrush is slowly replaced by the better forage species.

Ordinarily small rabbitbrush is not very palatable to sheep and very little of its herbage is utilized except on ranges which are heavily grazed.

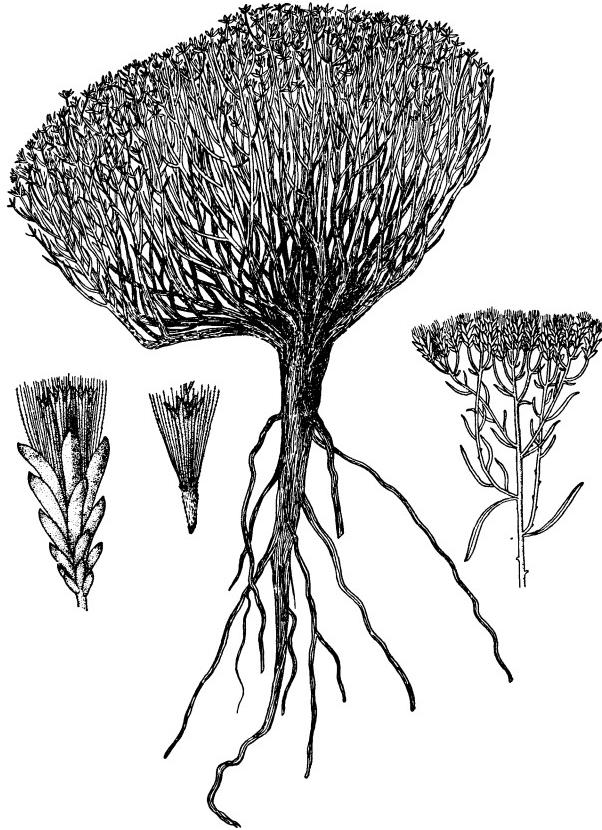


FIGURE 24.—Small rabbitbrush (*Chrysothamnus stenophyllus*).

Indian ricegrass (fig. 25) is a bunchgrass that grows 10 to 24 inches tall. The leaves are usually tightly inrolled and they feel round and smooth. The seed stalks when mature have open, loosely branched, and lacy tops. Mature "seeds" are dark brown or black, almost round, $\frac{1}{16}$ inch in diameter, and densely covered with white hair.

Indian ricegrass is one of the most important and palatable forage grasses on the winter range. It grows on the foothills and valley slopes intermixed with black sagebrush, winterfat, shadscale, or other species, but most abundantly on loose, sandy soils where it forms almost pure stands.

On many winter ranges, Indian ricegrass has been injured or killed by heavy grazing. Dead root crowns indicate its former abundance. When moderate grazing is applied to depleted ranges, increase in Indian ricegrass is one of the first indications of range improvement.

Indian ricegrass is palatable to sheep throughout the winter grazing season. In the early winter the seeds and seed stalks are relished. During the midwinter the leafy herbage is eaten and in late winter aftergrowth begins. The green leafage is succulent and nutritious and furnishes excellent forage.



FIGURE 25.—Indian ricegrass (*Oryzopsis hymenoides*).

Galleta (fig. 26), often called curly-mesquite or curly grass, grows in patches forming an open turf. It reproduces and increases largely by means of short rootstocks which are produced 1 or 2 inches beneath the ground. Ordinarily the basal leaves are 2 to 5 inches long and they curl up when dry. The flower stalks are often 8 to 15 inches in height. In some years when precipitation is favorable two crops of seed stalks and seed are produced; in dry years the plants often remain almost dormant.

Galleta, one of the most common grasses on the winter range, grows on the valley slopes mixed with winter-fat, black sagebrush, shadscale, and big sagebrush. On some areas it forms rather dense extensive stands. Its growth fluctuates widely with precipitation, the best growth occurring with summer rains.

Galleta is one of the desirable forage species on the winter range. It is readily utilized by sheep and on properly grazed range about half of the herbage is eaten. It withstands heavy grazing because of the rootstocks and growth habit. On many areas it often increases when other more palatable species are injured and killed. Under moderate grazing it is maintained in vigorous condition as a component in the vegetation.



FIGURE 26.—*Galleta* (*Hilaria jamesii*).

Russian-thistle (fig. 27) is an introduced annual which grows 8 to 24 inches tall. It is often called tumbleweed, because it grows in dense compact form and when mature rolls before the wind. During the summer Russian-thistle is bright green but in the fall it dries and turns reddish brown. When the plants are fully matured, the leaves are reduced, dry, and spine-tipped. The floral bracts and upper leaves are small, triangular, and spine-tipped.

Herbage from mature plants is harsh and unpalatable. Immature herbage which freezes and turns black is readily eaten by sheep when it is moistened by rain or soft snow.

On the winter range Russian-thistle grows primarily on disturbed areas and on overgrazed ranges where the native vegetation is destroyed. The most luxuriant stands are found on the fine soils in the valleys, and on depleted shadscale and winterfat ranges. It depends on summer rainfall for growth; in years with good summer precipitation luxuriant stands are formed while in drought periods little herbage is produced.

Under moderate grazing, Russian-thistle cannot compete with the native forage species and it is rapidly replaced as the ranges improve.

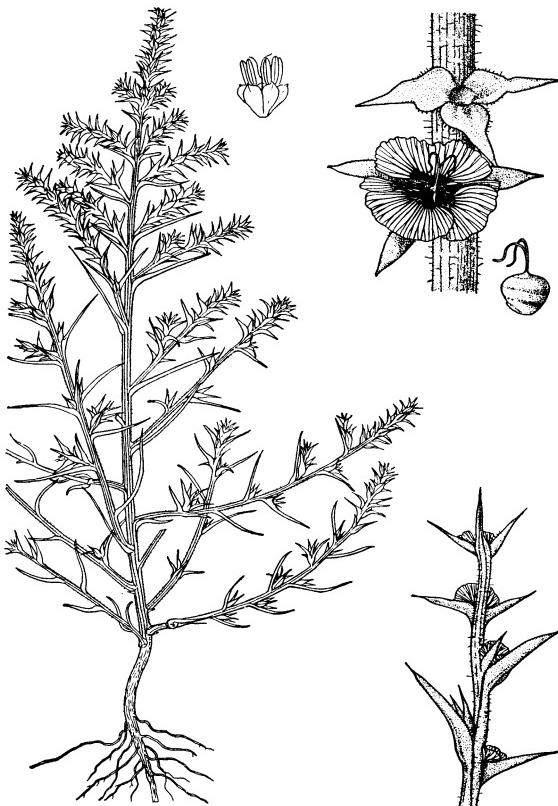


FIGURE 27.—Russian-thistle (*Salsola kali tenuifolia*).

Halogeton (fig. 28) is an introduced annual which grows 2 to 24 inches high. It grows in much the same habitat as Russian-thistle but prefers the finer heavily alkaline soils. *Halogeton* is distinguished from Russian-thistle by its red stems, the blue-green leaves and foliage, and the fleshy fingerlike leaves tipped with a single hair. In the fall the plants take on a reddish coloration.



FIGURE 28.—*Halogeton (Halogceton glomeratus)*.

Halogeton is an aggressive stock-poisoning plant introduced from southwestern Siberia. It was first found near Wells, Nevada, in 1934. Since then it has spread rapidly over the winter ranges covering extensive areas in Utah, Nevada, and Idaho and extending into Wyoming, Montana, California, and western Colorado. Heaviest infestations of halogeton are found on areas where native vegetation has been destroyed. It rapidly invades disturbed areas along roadways and depleted ranges. *Halogeton* produces large quantities of viable seed, the seed germinates in the late spring, and the young seedlings grow rapidly. Seed matures from September to November. On maturity the leaves and foliage contain approximately 20 percent oxalate. During the winter much of this leaches out.

Halogeton is not very palatable to sheep except in unusual circumstances.